BELL LABORATORIES RECORD

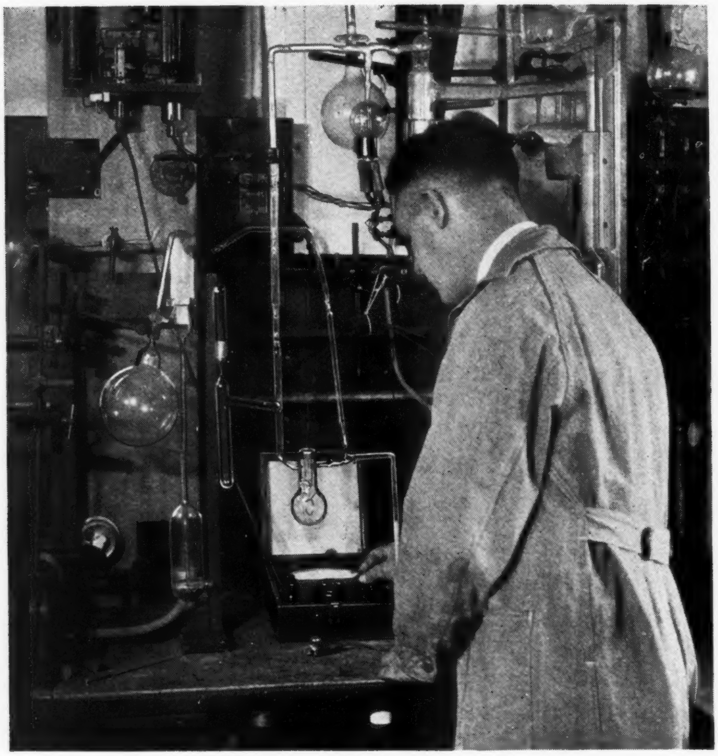
An air view of the Bell Laboratories building, taken by Mr. Paul C. Durbin

VOLUME NINE—NUMBER SEVEN

for

MARCH

1931



New Types of Photoelectric Cells

By A. R. OLPIN
Electro-optical Research

KNOWLEDGE of the photoelectric effect dates from 1887 when Hertz discovered that ultra-violet light, falling on a spark-gap, permitted an electric discharge to take place more readily than when the gap was in darkness. A second but allied effect was discovered the following year when Hallwachs observed that a well-insulated and negatively charged body lost its charge when illuminated with ultra-violet light. Both of these effects, although of the highest theoretical importance, were too feeble to be of any practical significance at the time. The evolution of the photoelectric cell as it is known today really began in 1889 when Elster and Geitel discovered that electro-positive metals such as sodium, potassium, rubidium, and caesium exhibited photoelectric activity when illuminated with ordinary visible light.

The history of the modern photoelectric cell has been essentially that of the development of a technique for the proper handling of these chemically active metals in a vacuum. Early advances were made by improving the degree of vacuum so that the metals could be used in a purer state. More recent developments have come from treating the surfaces of these pure metals with limited amounts of various gases or dielectrics.

In popular literature the photoelectric cell is frequently referred to as the "electric eye" because it is commonly employed to do the work previously done by human observers. The response of the electrical eye to light of various colors, however, has generally been quite unlike that of the human eye. Of the photoelectric cells using pure metals as the light-sensitive element, only those employing caesium exhibit a response to colors that even roughly approximates that of the human eye. This may be seen from Figure 1 which gives curves showing the photoelectric response of the pure metals and, in dotted lines, of the human eye to light of various colors. The ordinates of all curves have been multiplied by convenient factors to make their maximum values equal.

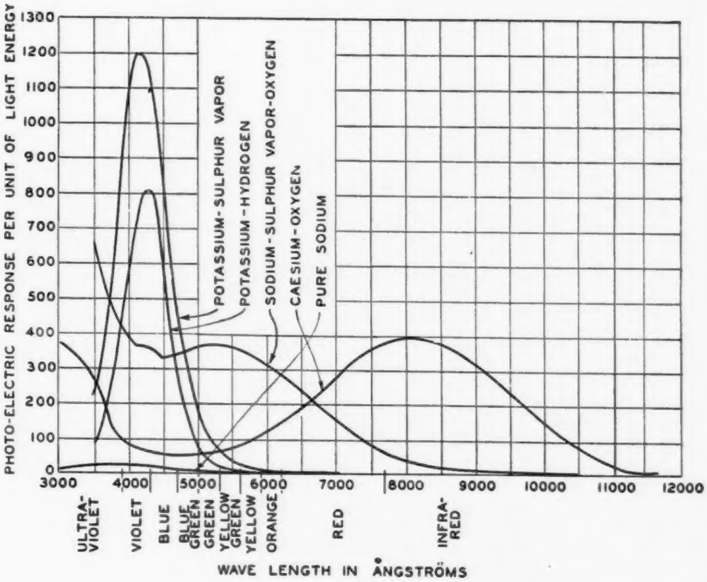


Fig. 2—By special treatment of the metal surfaces, the sensitivity is greatly increased and the points of maximum response are shifted in the spectrum. The curve for pure sodium is given for comparison

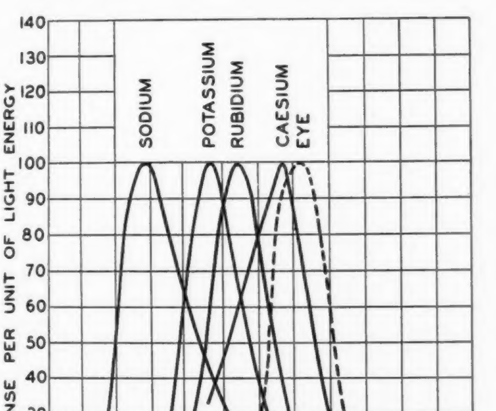


Fig. 1—Photoelectric cells using the pure alkali metals respond differently to light of various colors

The caesium which, of the pure metal cells, most nearly approximates the response of the eye, is difficult to make because caesium itself has such a strong affinity for oxygen and such a high vapor pressure that it is difficult to obtain or prepare in its pure form, and it is only the pure metal in bulk form that yields the form of curve shown. The rareness and consequent cost of the metal also contribute to make it impractical for general use.

That an electrical eye should have a response similar to the human eye, however, is not necessarily essential. The shape of the response curve of the eye does not affect the appearance

to us of an object in black and white — such as a photograph, an engraving, a printed page, or a pen and ink sketch. For correct reproduction of such objects all that is required is a response to difference in average intensities. The cell giving the greatest output per unit of incident energy would thus be the most desirable for such purposes. The No. 1-A photoelectric cell used up to the present time in picture reproduction and similar fields, has been one of the best cells available in spite of the fact that it responds selectively to blue light and is insensitive to red. The cell is made by ionizing hydrogen on a surface of potassium — a treatment which, as Elster and Geitel discovered about twenty years ago, considerably enhances the emission of electrons without greatly changing the color response from that of pure potassium.

Recent advances in photoelectric cells have been made by treating the surfaces of alkali metals with gases other than hydrogen, or with vapors of various dielectrics such as sulphur or organic dyes. The results have been very satisfactory. The selective response has been found to depend not only on the materials used but on the ratio, in the surface compound, of the number of atoms of the sensitizing material to the number of atoms of the alkali metal. This ratio is usually very small and the technique for controlling it varies for the different metals because of the large differences in vapor pressures and chemical affinities. In many cases small amounts of a suitable dielectric are sublimed from a side tube or small amounts of gas are introduced from a nearby bulb. In other cases, particularly where caesium is used, the procedure is decidedly more involved.

The actual response to equal amounts of energy of various wave-lengths of four of such cells is shown on Figure 2. The high sensitivity of the potassium-hydrogen cell to blue and violet light is here evident, but sensitivity at these wave-lengths is even greater for the potassium-sulphur cell. Such curves, however, giving the response of cells to equal quantities of energy at different wave-lengths, do not tell the entire story.

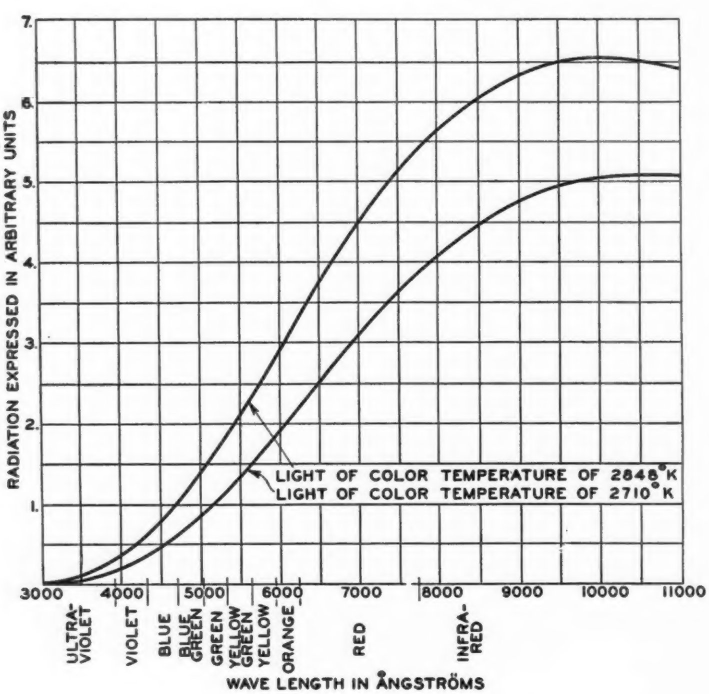


Fig. 3—Tungsten light sources radiate the greatest amount of energy at the longer wave-lengths, but the actual distribution depends on filament temperature

The effectiveness of any particular cell depends not only on its response curve but on the energy distribution of the light source with which it is used. Typical energy distribution curves for two types of incandescent lamps are given on Figure 3. From the curves it will be seen that by far the greater part of the energy is radiated at wave-lengths longer than yellow.

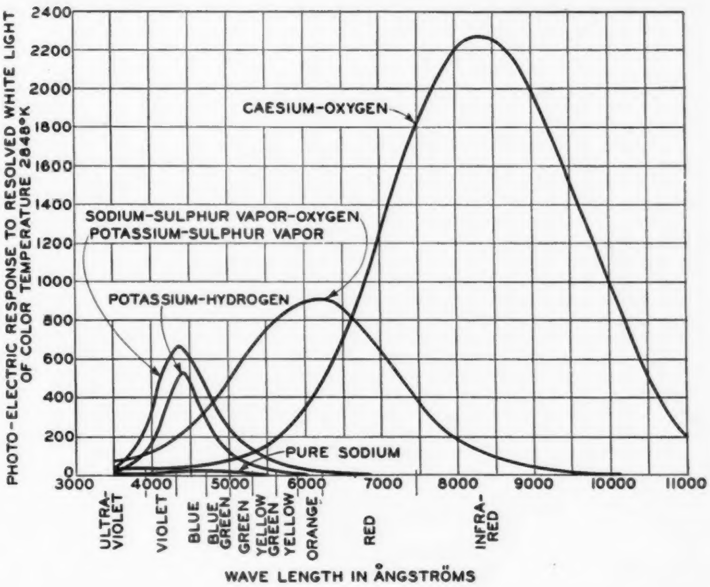


Fig. 4—The response of a cell to light from a tungsten filament depends on the characteristics of both cell and filament

The response of cells to light from such sources is proportional to the product of the ordinates of one of the curves of Figure 3 by those of the curves of Figure 2. The resulting response for the five cells plotted is given on Figure 4. The total response per unit of illumination is equal to the areas under these various curves. The response of the caesium-oxygen cell, which from Figure 2 might seem to be less than the others, is actually the greatest where the source of light is a tungsten lamp.

For such systems as sound picture or picture transmission where incandescent lamps are used as light sources and where, because only differences of intensities need be reproduced, no attention need be paid to color distribution, a caesium-oxygen cell has great advantages. For television, on the other hand, particularly where full color is to be reproduced, the requirements are different. In the color-television system, demonstrated by the Laboratories in 1929, a satisfactory response was obtained by using both potassium-sulphur and sodium-sulphur-oxygen cells. The combined response of the two cells satisfactorily reproduces all colors.

Another interesting application of the use of cells of different responses was made in the recent demonstration of two-way television. Here a person at one end, at the same time that he is seeing the image of the person at the distant end, is being scanned by a beam of light so that his image may be transmitted. Early trials were made using cells sensitive only to blue light and employing a blue beam for scanning so as to obtain a light that would not dazzle the eyes of the observers in the booth. The potassium-sulphur cells were used. The system was very satisfactory in so far as glare from the scanning beam was concerned, but because only blue light was employed, the reds and yellows in a person's face did not appear quite natural in this reproduced form. To

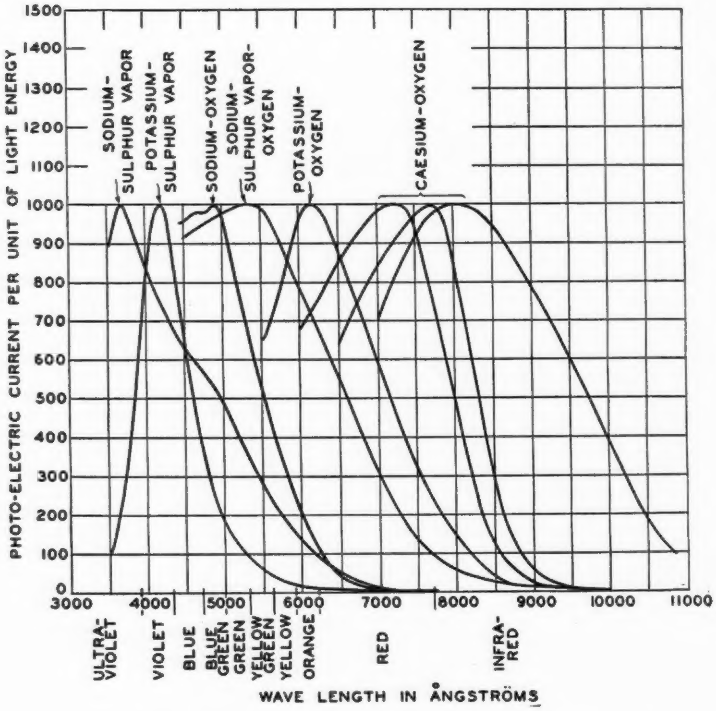
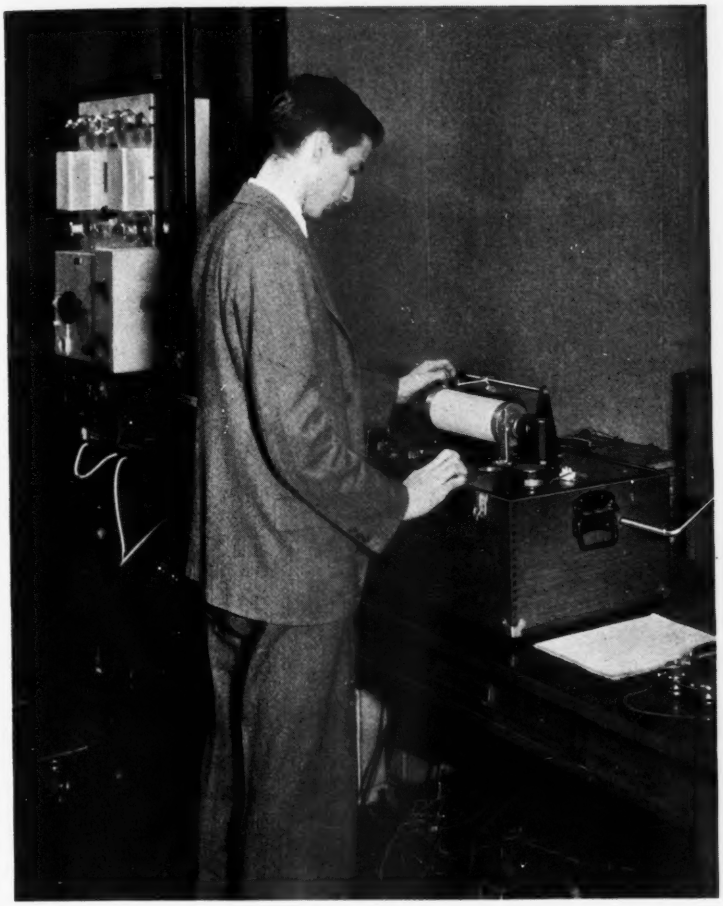


Fig. 5—Response curves having their maximum value at almost any wave-length may be obtained by proper treatment of the alkali metals

improve this feature some caesium-oxygen cells were added. These cells reproduce the reds very well and to make them effective a red component was added to the scanning light which changed it from a blue to a purple. The purple light is just as satisfactory from the standpoint of glare, and the resulting image, because of the presence of reds, is much more natural. From Figure 4 it will be noted that the combination of these two cells is practically insensitive to yellow light so that the booth may be lighted with a low-intensity yellow light without affecting the television transmission.

Photoelectric-cell manufacture has now reached the point where selective response to light of almost any color may be obtained. Curves for some of these cells, which although made for experimental purposes are not commercially available, are shown on Figure 5, but the curves are not complete as most of them have other selective maxima in the ultra-violet region. The study of methods of sensitizing alkali metals is being continued. Among the profitable results already obtained are many valuable theoretical deductions which promise to aid greatly in the further development of the subject.



Measuring Reverberation

By CARL F. EYRING
Sound Picture Laboratory

AS the auditorium has evolved from a gentle slope on a hillside through the Greek Theatre to the modern enclosure, more and more of the sound energy which otherwise would have escaped has been pent up. In the open the sound flows out into space and is lost. When a wall is placed behind the source some of the energy is returned by reflection and the sound intensity in front of the wall is increased. The addition of another wall makes possible multiple reflections with an attendant increase in sound intensity. In an enclosure such as an auditorium the sound is returned many times by multiple reflection and the sound intensity is correspondingly augmented. At each reflection, however, there is also absorption and the number of reflections which a wave can survive depends upon its initial intensity and the absorbing power of the surfaces from which it is reflected. In a "live" room, one with walls only slightly absorbing, the wave makes many trips about the room before it is completely absorbed.

In a "dead" room, on the other hand, one with walls highly absorbing, the wave makes only a few trips before its energy is entirely exhausted.

Each component wave element of sound in an auditorium has a definite period of life which begins when that wave is given off by the source of sound, and ends when its intensity falls below the threshold of hearing. During this life period of any one sound wave, its intensity decreases in steps —falling a constant proportion with each reflection. The total sound intensity in the room is the summation of the waves just sent out by the source and the various trains of waves which have been reflected and re-reflected from the walls and fixtures in the room. From the beginning of emission of sound to the first reflection, the intensity of the sound in the room is that of the direct waves; from then until the second reflection it is that of the direct wave train plus the contribution of the reflected waves. This building up of the intensity continues until there have been so many reflections that the intensity of the first emitted wave is negligibly small.

There is a definite period, therefore, before the sound intensity in a room reaches its full value. The source is constantly emitting new sound waves and each wave is being reflected back and forth from the walls and fixtures, and, although losing part of its intensity at each reflec-

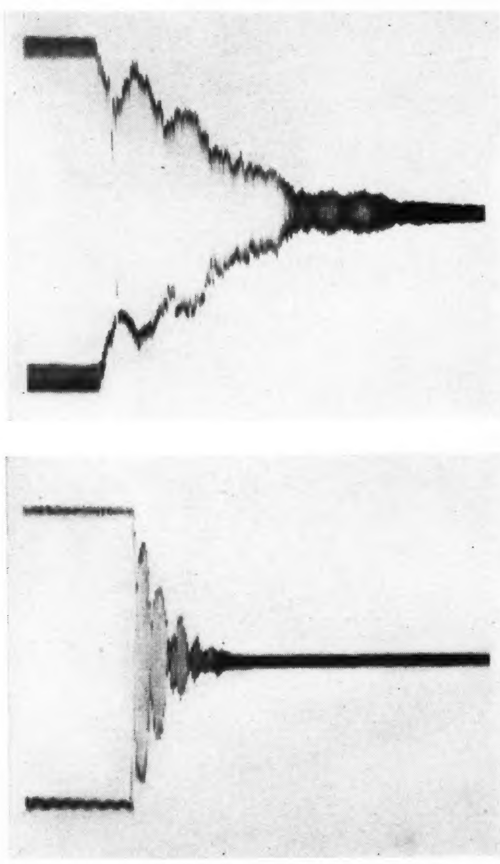


Fig. 1—Oscillograms of the sound decay in live and dead rooms although showing plainly the difference in reverberation time also make plain that the sound decays in an irregular manner

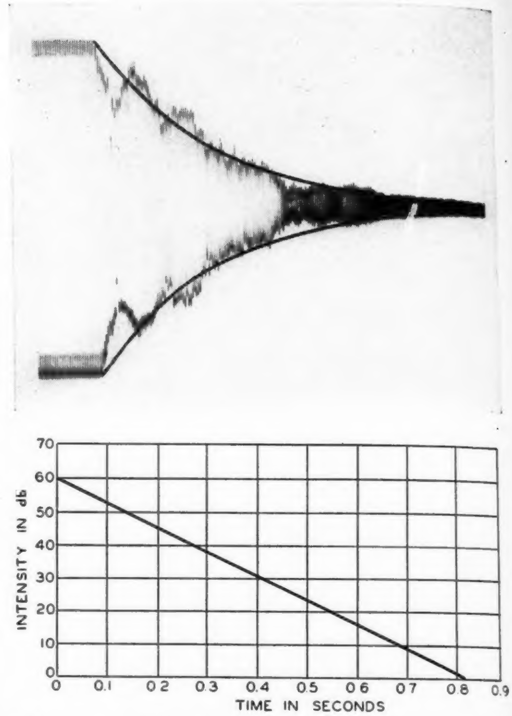


Fig. 2—The best representative smooth curve for the decay of sound in a live room (above), is a straight line when plotted to a logarithmic scale which converts the ordinate scale to db in intensity

tion, is adding its remaining portion to the sound already in the room. This period of building up is thus equal to the time required for any one wave to have been reduced, by reflection, to an intensity below the thresh-

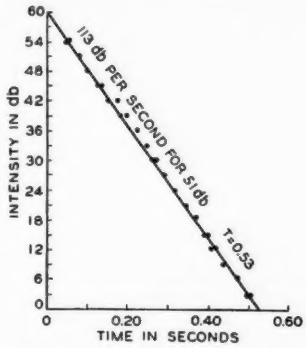


Fig. 3—Under diffuse conditions, the decay of sound follows a single straight line

old of hearing, that is, to that intensity which will no longer add an audible component to the sound already in the room. It is thus the life span of a single sound wave that determines the time required for the sound in a room to attain its full strength.

In a somewhat similar manner the life span marks off the period between the cessation of sound emission and the actual disappearance of the sound. When a source is cut off, the last emitted wave will have its full life span to live, and a certain wave will have just reached its death level. From this time on no new waves will be born, but the death rate will continue unabated until the last wave has disappeared.

The life span of a sound wave (or the period for which sound persists after emission has ceased, in other words) is controlled by the power output of the source, by the average distance between reflections, and by the fractional part of the energy absorbed on each reflection—or the average coefficient of absorption of the walls or other obstructions in the room. With fixed room conditions, therefore, this period varies only with power output, and when the intensity produced is a million times the minimum audible intensity, the period is called the reverberation time for that particular room. This term was first used by W. C. Sabine, and the value of intensity selected was that obtained from the organ pipes used for most of his work.

Reverberation time, however, marks merely a period during which the sound drops a definite amount in intensity. No information whatever is given by it as to the relation of sound intensity to time within the period. Rooms in which sound decayed in quite different manners might yield the same reverberation time. Although, therefore, reverberation time is easily measured, it is of little use.

That the actual rate of decay of sound is not constant may be shown by connecting the output of a transmitter to an oscillograph and obtaining an actual graph of the decaying

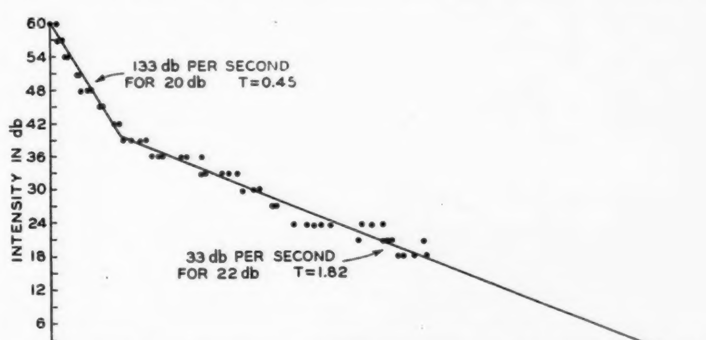


Fig. 4—With resonators present, the decay curve may be composed of two or more straight lines

sound pressure. Such curves for a live and dead room are shown in the oscillograms of Figure 1. If through the oscillogram for the live room the best representative smooth curve be drawn, the result will be as shown in Figure 2. When this curve is plotted with the intensities in db above threshold as ordinates, the result is a straight line, also shown in Figure 2. The interpretation is that the decay follows an exponential law: during equal intervals of time the intensity is decreased by equal proportionate amounts. This is what would be expected on the average when the losses are all due to reflection, since at each reflection an equal proportion of the intensity is lost. The wavy nature of the oscillogram is due to shifting of the interference pattern caused by the successive disappearance of certain reflected waves.

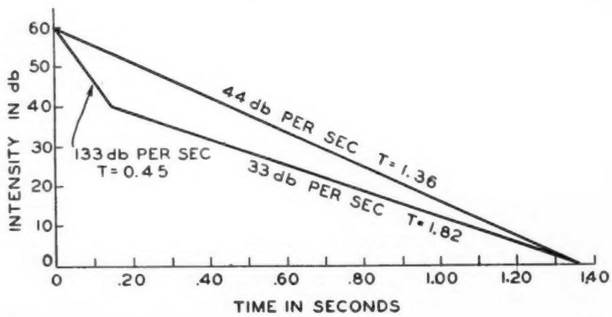


Fig. 5—Measurement of reverberation time only, yields an average decay rate unlike both of the rates actually existing

An apparatus recently developed by Wente and Bedell of our Acoustical Research Department has proved very useful in bringing out these facts of auditorium acoustics. It records the loss of intensity in db at short intervals, and by drawing a representative straight line through the points so determined one readily obtains curves similar to that in the lower part of Figure 2. Some of the wavy character of the curve, so evident in the oscillogram, is still evident in the points plotted by the new instrument, but if a warble tone is used as the sound source, that is a note whose frequency changes back and forth over a range of 100 cycles or so, the wavy characteristic is greatly reduced.

Studies with this instrument have shown that in a single room in which sound waves travel in all conceivable directions, which is known as a diffuse condition, the decay curve is a simple straight line as shown in Figure 3. The reverberation time for such a room is given by the intersection of the curve with the axis of time. If resonant bodies are present in the room however, such as panels set into vibration by the sound, or if a live room is connected to a dead room, or if sound waves in one part of the room, because not diffuse, persist longer than the diffuse waves, then the decay curve may be represented in an average way by two straight lines as shown in Figure 4. In all these cases a resonant or live portion of the room acts as a decaying sound source to a dead portion.

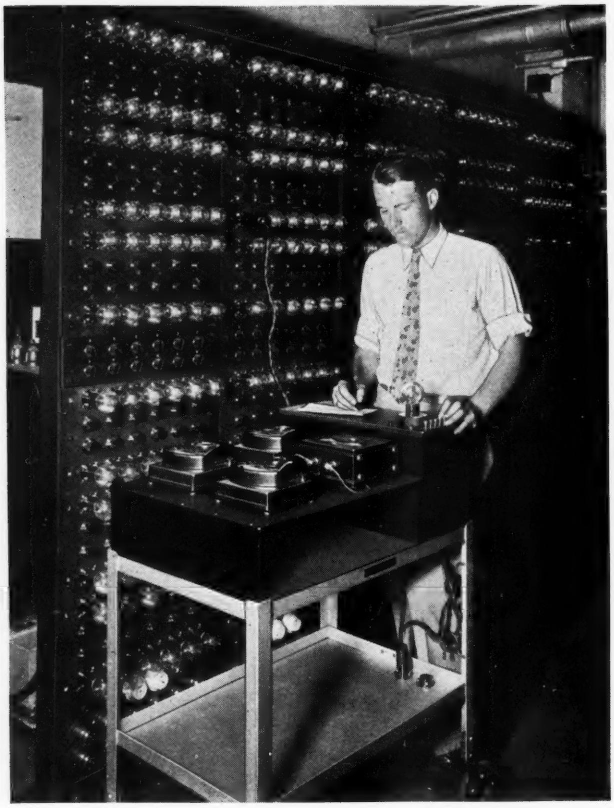
The change from one rate of decay to another does not take place at a particular sound intensity but at a definite number of db down from the original value. In the room to which the curve of Figure 4 applies, the sound decays at a rate of 133 db per second for 20 db regardless of what the original intensity was, and then after a more or less rapid transition at the rate of 33 db per second from there on. The significance of this is that for sounds not greater than 20 db above the room noise, the decay

rate is 133 db per second which corresponds to a reverberation time of .45 second when defined in the usual manner. Had a person actually measured the reverberation time for the room, however, it would have been found to be — due to the double rate of decay — 1.36 seconds. This value of reverberation time — on the assumption of a uniform rate of decay — would have indicated a decay rate of 44 db per second which is correct for neither portion of the actual curve. The relationship which has been described is shown graphically in Figure 5.

It is evident from these results that the acoustical properties of a room cannot be accurately given by reverberation time alone. This term, which arose in an early stage of acoustical measurements, is no longer suited to our wide knowledge. Rooms of quite different characteristics might have the same reverberation time. Rate of decay is the important factor, and each rate, with the range of drop in intensity over which it applies, should be given to characterize a room.

A Death in the Desert

Caught far from Bell System maintenance and with no friendly engineer to come to its aid, this luckless telephone was overwhelmed by a band of cross-talk bugs. In a larval stage, these insects were found as the wiring of certain experimental apparatus. Their predatory character was revealed to the camera after they had been removed in the course of rewiring the apparatus



Life Testing of Vacuum Tubes

By G. H. ROCKWOOD
Vacuum Tube Research

SATISFACTORY characteristics over a long life is one of the important requirements of vacuum tubes for the Bell System. Life testing, therefore, is an important function of the groups concerned with vacuum-tube development, and equipment must be provided which—because of the extreme length of life and the large number of tubes that must be tested—will give the necessary information with a minimum of effort. To meet this requirement for certain classes of tubes, new circuits have recently been developed which combine economy of space with a maximum ease of making the necessary periodical readings.

Twelve circuits, each arranged for testing six tubes, are mounted on a single bay of relay rack. Expansion of the testing facilities is easily accomplished by the installation of additional bays. Plate voltage is the same for all tubes under test but grid potential is separately adjustable for each circuit, and filament current, for each tube. The six tube-sockets for each circuit are mounted in a horizontal row, and directly above or below each socket is the rheostat for controlling the filament current. In

the middle of the bay are the twelve grid-bias controls, and at the bottom, twelve switches for connecting or disconnecting plate potential to each circuit. The arrangement is shown in Figure 1, and a schematic diagram of a single circuit is given in Figure 2.

Cathode or filament temperature is the most important operating parameter of a tube, and it may be controlled by regulating either the filament current or voltage. In the usual repeater station, filament temperature is controlled by current regulation, and since in a life test it is desirable to duplicate service conditions as far as possible, the control of filament current was selected as the best method. Filament power is supplied by a small transformer in each circuit which is fed from a 110-volt sixty-cycle source through a voltage regulator of the saturated-iron type. The regulator is so designed that it supplies the transformer primary with a constant voltage regardless of load conditions or line voltage. Because of this constant voltage the filament current remains fixed at the correct value once the rheostat in the filament circuit has been adjusted.

Grid biasing potential is obtained from a battery of dry cells which is provided with end-cell taps. These are run to each of the twelve grid control switches on each bay as indicated in Figure 2. Since the plate voltage remains fixed, the plate current is controlled only by the grid potential.

One of the important features of the life testing circuit is the protection against short circuits between the filament and grid. From Figure 2 it is evident that, should a filament of one tube burn out and fall against the grid, a short circuit would be placed across the grid battery which would affect all the tubes under test. Harm from such an accidental short circuit is prevented by a two-winding relay incorporated in each circuit.

The grid connection from the end-cell switch is carried through a back contact and one of the relay's windings. The second winding of the relay is connected to the plate supply through a front contact. Under nor-

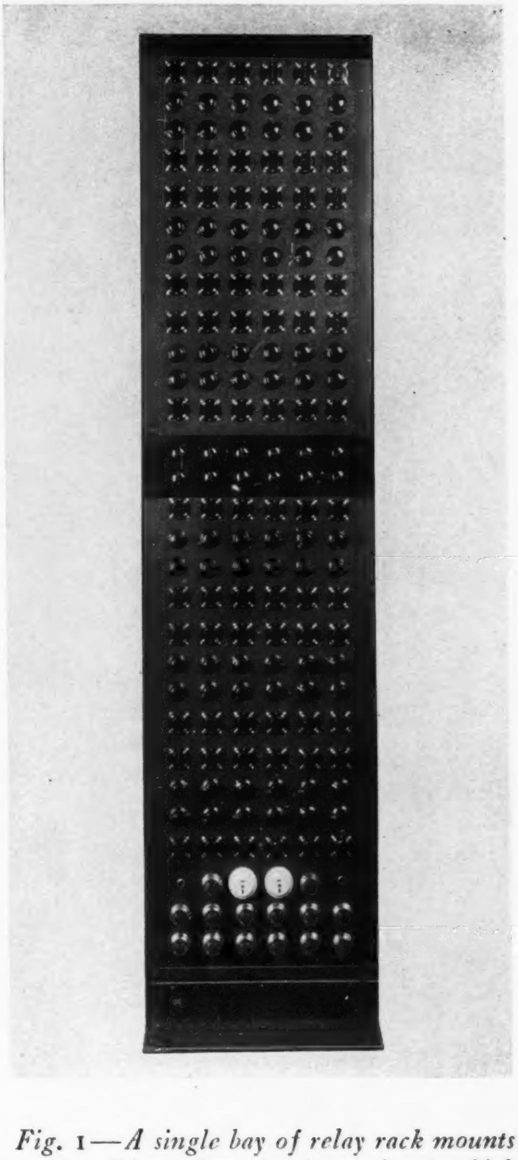


Fig. 1—A single bay of relay rack mounts twelve life-testing circuits each of which accommodates six tubes

mal conditions the relay remains unoperated, but should a short circuit occur, the heavy current that would momentarily flow in the grid circuit would operate the relay which would then hold itself operated by the second winding. With the grid circuit opened, the other tubes of the test circuit would draw an excessive plate current because of the lack of grid bias. To avoid this the plate circuit is carried through a back contact on the same relay and is opened when the relay operates. A third back contact on the relay opens a lamp circuit and thereby calls attention to the disabled condition of the circuit. After the defective tube has been removed, the circuit may be put in operation by turning off the plate voltage which allows the relay to release, and then turning it on again.

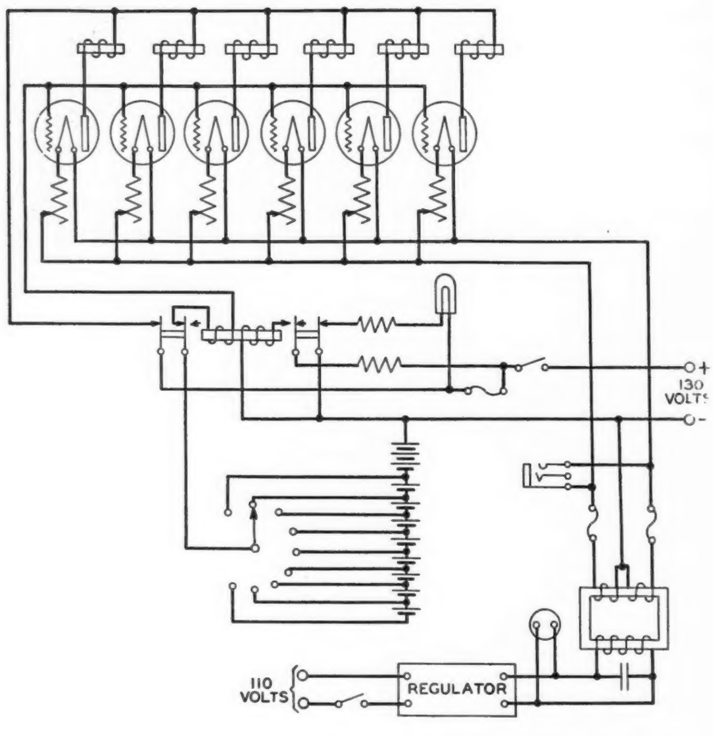


Fig. 2—Each circuit includes a single adjustment for grid potential and six filament rheostats as well as protective devices and a regulator for filament voltage

Both plate and filament circuits are protected by fuses. Since it is desirable to burn free any short circuits that occur within the tube in the filament circuit, its fuses are large and are relied upon only to protect against failures in the wiring. Plate fuses, on the other hand, are more closely proportioned to the operating current.

It will be noticed that no meters whatever are indicated in the circuit. Once the filament rheostats and grid switches have been set at the proper positions, the circuit will maintain operation and provide all necessary protection, but no provision is made in the circuit itself to determine the proper settings or to determine subsequently the characteristics of the tube.

Meters for each circuit would have greatly complicated the wiring and necessitated fewer circuits per bay. For the large number of circuits required this would have meant a large increase in space requirements. Above all, however, the cost of the large numbers of meters would have been excessive. As an accessory to the test circuits, therefore, there is a meter circuit which is mounted on a tea cart so that it may be wheeled into position in front of any test bay. Operating procedure removes a tube from its socket on the bay and inserts it in

a socket on the tea cart. A plug connected to the meter circuit is then inserted in the socket from which the tube was taken. Then by use of the meter circuit the filament rheostat and grid switch may be properly set at the beginning of a test, or subsequent readings of tube performance may be taken when desired. The arrangement is shown in the headpiece.

One of the interesting features of the meter circuit is the method of compensating for the resistance of the ammeter used in the filament circuit. The resistance of the filament circuit is low and the insertion of an alternating current ammeter introduces enough resistance to seriously affect the value of the current flowing. This error has been avoided in other life racks by the use of a telephone jack so wired that when the meter was not in the circuit a resistance equal to the meter impedance took its place. This method was felt to be unsatisfactory for the new equipment owing to the space requirements of the jacks and to the trouble that has been experienced with them when operating at the large currents and high ambient temperatures usually prevailing.

When a tube is operating on a rack there is a series circuit consisting of a filament transformer, rheostat, and tube. If a meter were inserted the impedance of the circuit would be changed and the filament would no longer be taking the correct current. The original conditions could be restored, however, if an impedance equal to that of the meter but of opposite sign were inserted. This scheme is employed in the metering circuit used with the life racks. The arrangement is shown in Figure 3.

A transformer in the metering circuit is supplied, from the same source that supplies filament current, through a polarity outlet which insures that the desired phase relation between the two branches of the circuit is always maintained. This transformer supplies current to a compensating resistance R, and is in such phase relation to the current through the meter that the drop across R is always opposite in sign to that through the meter. The current through R, and hence the voltage drop across it, is adjusted to the proper value by the rheostat *r*. To make this adjustment

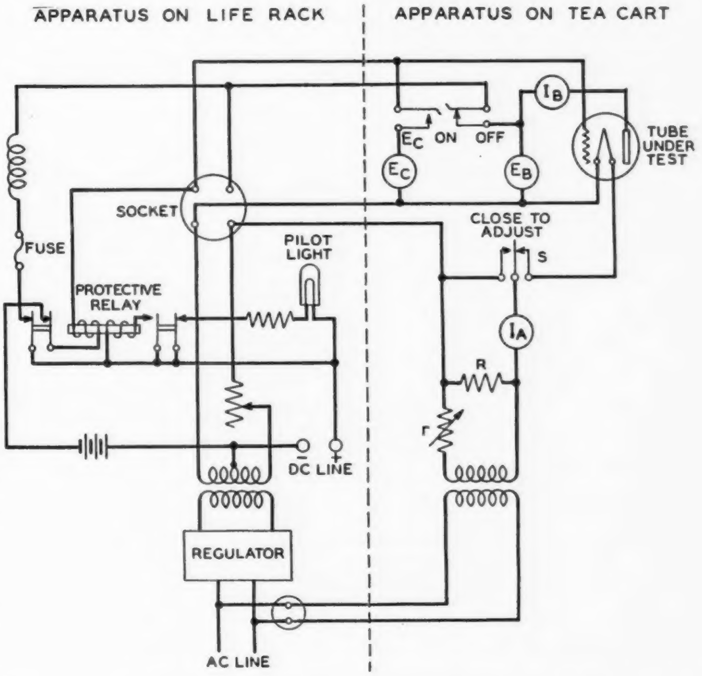
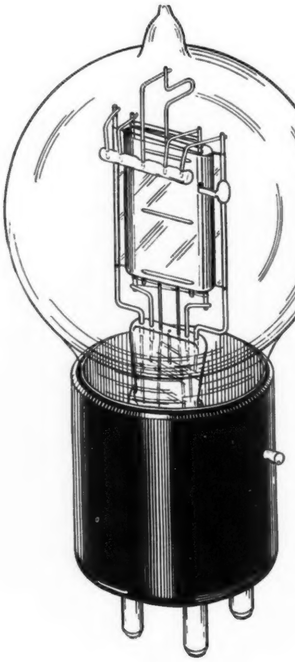


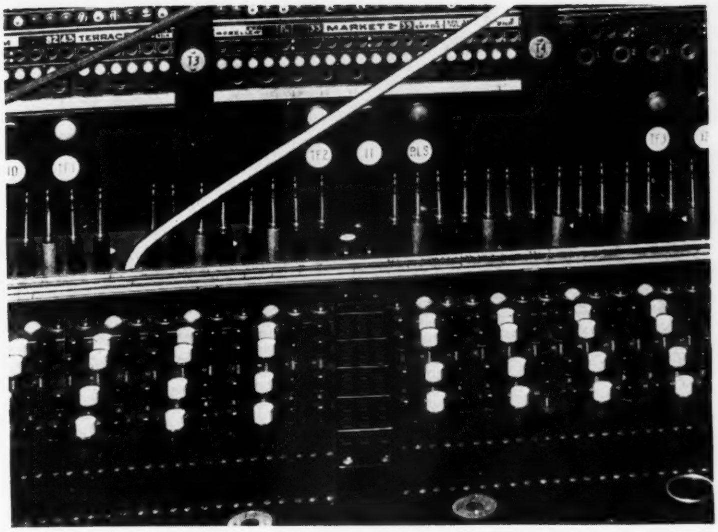
Fig. 3—Schematic showing use of meter circuit in conjunction with life rack

the switch S is operated, which connects the ammeter across R, and the adjustable resistance is then varied until the meter indicates the current which the filament of the tube should carry. Under these conditions the voltage across R is equal and opposite to the drop through the meter so that no error in the reading of filament current will be caused by the insertion of the meter.

The tea cart also contains meters for reading the grid voltage, plate current, and plate voltage but no special precautions are necessary when taking these readings.

At the beginning of a life test, the tea cart is wheeled into position and the adjustments of filament rheostats and grid switches made to give the proper operating conditions. From then on the life circuit maintains these conditions constant and no further use of the meter circuit is required except for readings taken periodically to determine the operating state of the tubes. By the combination of life-test circuit and meter circuit, facilities are provided for life testing which require a minimum of space and expense, and yet allow a ready determination of the life conditions at any time.

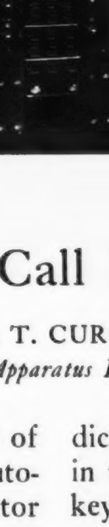




A Small Call Indicator

By S. T. CURRAN
Telephone Apparatus Development

ONE of the chief purposes of the development of the automatic display call-indicator system was to facilitate the conversion of existing straight-forward or call-circuit positions in manual offices to call-indicator operation. Where party ringing is employed, so large a part of the keyshelves of such positions is occupied by the ringing keys that there is not room for the earlier type of indicator.* It became necessary, therefore, to develop a smaller indicator, and the requirement was set that it should fit into the space occupied by two standard ringing keys.



To display all possible numbers, forty-six lamps are required, and the design of an indicator to mount this number of lamps in the space required for two ringing keys—only 1 1/8 x 7 1/2 inches—presented a very interesting problem. The required arrangement of lamps is as shown at the left. Until the present necessity arose, the shortest center distance for mounting lamp sockets was 7/16 inches across the lamp contact members and 3/8 inches at right angles to them. Simple arithmetic indicated that it would be necessary to reduce these mounting dimensions considerably if the overall requirements were to be met. A lamp itself may measure as much as .300 inches across terminals so that three of them abreast leave only .225 inches for the necessary four walls and six contact members, as well as for clearance for each lamp and at the sides of the indicator itself

* BELL LABORATORIES RECORD, *July*, 1930, *p.* 515.

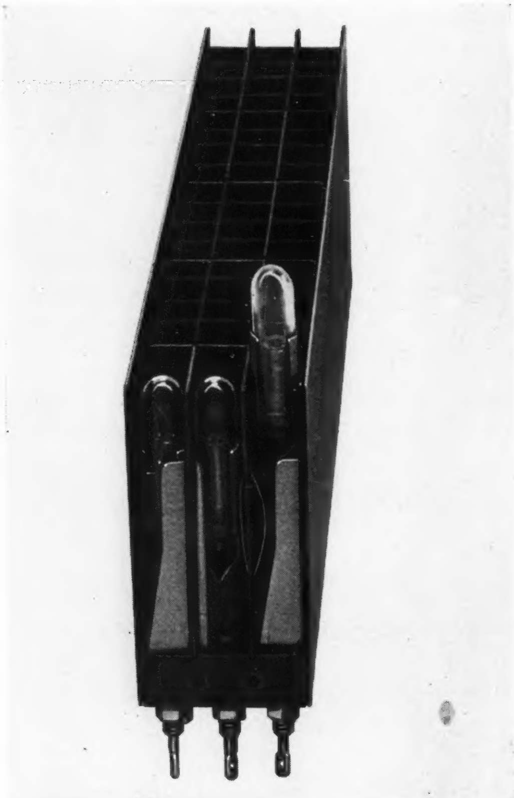


Fig. 2—The contact arrangement for the small indicator consists of springs riveted to two metal walls, and special contact strips on the other two walls

which is necessary to prevent interference with adjacent apparatus.

The design finally adopted is shown partially in Figure 2. It was found practicable to have the contact members for one terminal of each lamp connected together electrically. This permitted the use of metal for two of the four longitudinal walls. These are the first and third from the left of the illustration, and the common spring connection is provided by comb-shaped metal strips soldered to the metal wall. The one on the left hand outer wall is shown in Figure 3. The flat metal teeth of these comb-like pieces are bowed out to supply sufficient contact pressure when the lamps are inserted. A heavy terminal is brazed to each of the common-contact walls and extends through holes in the base block to form easily distinguishable terminals.

The other terminal of each lamp makes contact to a separate metal part in each lamp cell with a flange on one side which widens out at the base to hold it tight against the dividing wall. The backs of these parts are bent in at the bottom and fastened by screws which extend through the base and have their ends flattened to form

Fig. 3—Comb-shaped metal sheets soldered to two of the side walls make contact to one terminal of each lamp

soldering terminals. The second wall from the left of Figure 2 which separates two rows of these individual contacts, is of phenol fibre as are all the transverse walls.

To secure greater stiffness when the lamps are pressed into place, both the

outer walls are of metal and are tied together at intervals at the top. The blank positions opposite each "O" digit gave room for this tying by means of narrow strips of metal which are bent over at each end and riveted to the outside walls. The longitudinal walls at these positions are slotted to allow these bracing strips to pass through them. Since individual contact strips are required along the right hand outer wall, a thin strip of phenol fibre runs along its entire length to serve as insulation. This strip and the transverse metal braces may be seen in Figure 3, which shows the frame top down.

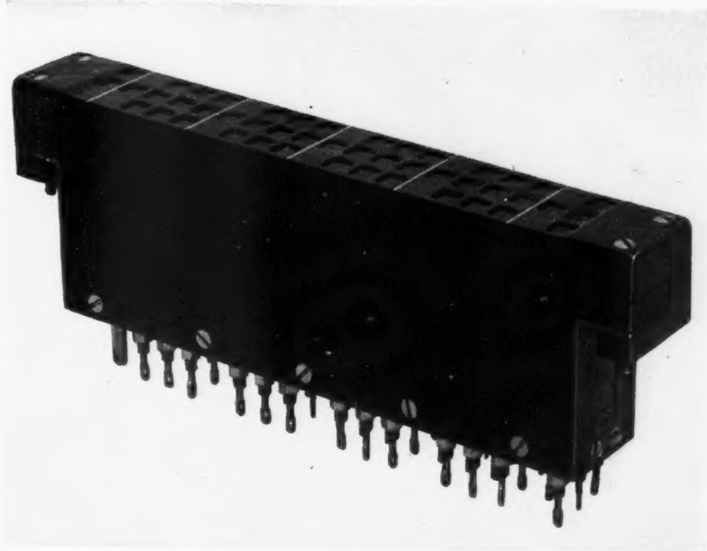


Fig. 5—An assembled indicator of the No. 12-A type showing spacing between side plate and top

The difficulties in design of the new indicator arrange themselves into two groups. One includes all the various contrivances required to mount so large a number of lamps within so small a compass. These, in the main, affect the body of the indicator as already described. The other group was responsible for construction modifications which would allow the small, closely spaced numerals and letters to be seen not only by an operator at the position where the indicator was mounted but by those at the adjacent positions when teamwork or grouping arrangements made this necessary. The earlier indicators had heavy glass-plate tops which, if used for the smaller digits, would naturally cause distortion unless the indicator face were viewed from almost directly above. For the new indicator it was necessary to do everything possible to reduce to a minimum the thickness of the protecting parts above the digit markings.

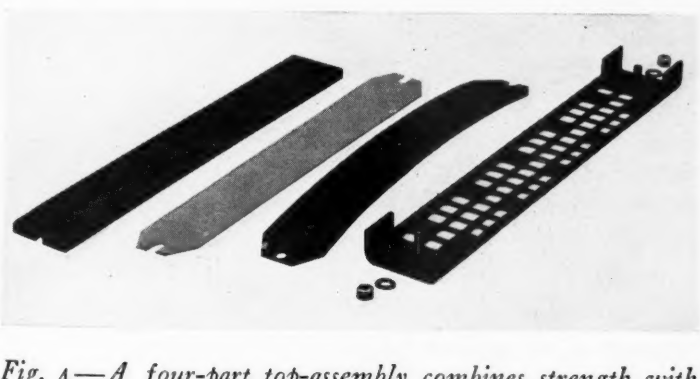


Fig. 4—A four-part top-assembly combines strength with minimum thickness. The digits on the film are a dull blue green and do not show clearly in the illustration

Four separate parts compose the top plate assembly which covers the cellular indicator body. First comes a strip of phenol fibre

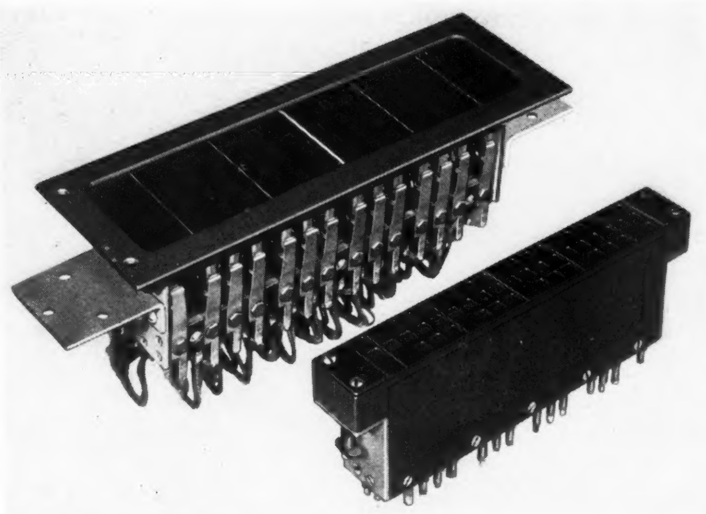


Fig. 6—The new indicator is about forty percent smaller than the earlier type

edge and at the ends, as shown in Figure 5. As an additional precaution, the side plates are given a coating of insulating japan beneath the finishing coat. A metal plate screwed to the phenol-fabric base holds the top plate in place. An intermediate block of phenol fibre, fastened both to the end plate and to the top-plate assembly, serves as insulation between them. A sheet of phenol-fibre covers the inner surface of the two metal end brackets.

which fits tightly over the transverse and longitudinal divisions, and prevents leakage of light between cells. A hole is drilled through this piece directly over each lamp. The digits are printed on a thin photographic film made of cellulose acetate, and to strengthen this film a thicker sheet of clear cellulose acetate is placed between it and the phenol fibre strip beneath. Directly on top of the photographic film is placed the metal cover with rectangular openings cut for each of the digits. These four parts are shown in Figure 4. The metal sheet is made of 1/16 inch stock but is milled down to .020 inches over the area including the square holes to make the digits visible from as wide an angle as possible.

It is very desirable that no metal exposed above the face of the keyshelf be connected in any way to any of the electrical circuits of the switchboard. To insure complete insulation of the metal top, therefore, an adequate gap is left between it and the two metal sides, both along the top

The relative appearance and size of the new and old indicators are shown by Figure 6. Three types of the new indicator have been developed. The No. 11-A and No. 12-A, the latter of which is shown in Figure 5 and the former in Figure 6, are alike except for the method of mounting. The No. 11-A mounts in universal keyshelves with the cover plate level with the top of the push buttons of adjacent ringing keys as shown in the headpiece. The No. 12-A is designed for similar mounting but for the old style keyshelves. The No. 13-A is arranged for mounting lengthwise in keyshelves having "B" length keys. The main body and top of this indicator are like the others but the digits are printed so as to be read when viewed from the side rather than from the end. The top of the indicator is mounted approximately flush with the keyshelf and an escutcheon plate is furnished which fits snugly around the indicator and is screwed into the keyshelf.

Damping Methods for Electrical Reproducers

By D. G. BLATTNER
Transmission Instruments Engineering

IN the usual types of electrical reproducers, such as those used with phonographs or sound pictures, the efficiency of the vibrating system is not constant but varies with frequency. These devices usually consist of one or more vibrating parts which may be linked together in a variety of ways, and the efficiency increases as resonance is approached so that a curve of response plotted against frequency shows one or more peaks, as indicated in Figure 1, instead of being a smooth line. Such variation in efficiency is undesirable in sound-reproducing devices, and is sometimes reduced by the addition of one or more dissipative, or resistance, elements.

The effect of a resistance used with one or more mass and stiffness elements is to reduce the efficiency over the entire frequency band due to the increased impedance to motion that it causes. The effect becomes much greater as resonance is approached, however, because in the neighborhood of the resonant frequency the resistance becomes the dominant component of the impedance and reduces the velocity to a greater extent than at other frequencies. Because of this action, the result of adding a resistance element to a sound-reproducing system is to lower the efficiency slightly at all frequencies but to a very large extent at resonance, and thus to smooth out the efficiency curve.

The effect of resistance elements on vibrating systems has long been known, and the element employed has assumed various forms. Occasionally, it has been represented by the dissipation in one or more of the vibrating elements, as when diaphragms or levers are made of paper or wood. The results of such damping methods have usually not been altogether satisfactory because the dissipation obtained is too small in comparison with the mass and stiffness of the member.

In other systems a separate dissipative element has been employed which has no function other than that of providing damping. An illustration of this type is the rubber placed between the armature and the pole pieces of some types of reproducers for electrical phonographs. Such constructions are similar to the above

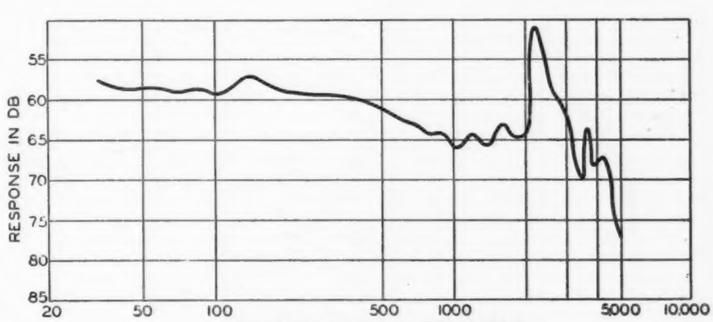


Fig. 1—Response characteristics of a No. 4-A reproducer without damping

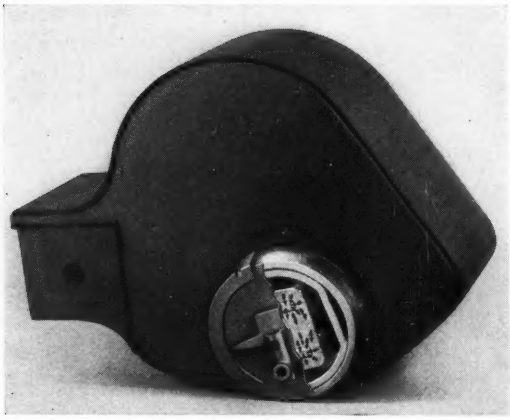


Fig. 2—Movement of the oil giving the damping effect in the No. 4-A reproducer is indicated by arrows

type in that in providing damping the rubber adds appreciably to the mass and stiffness of the moving system, and where minimum values are desirable from the standpoints of tracking and of wear on the record, this form of resistance element like the other has not been entirely satisfactory. It is possible, of course, to employ rubber with more satisfactory results as is done in the Western Electric electro-mechanical recorder, used for making phonograph records. In this case a long rubber line is used as a torsional load on the vibrating system and the stiffness is not a controlling element. Unfortunately, however, this form of damping element is not readily adaptable to the electrical reproducer because of size, complexity and cost.

Other forms of dissipative or resistance elements, used from time to time to equalize efficiency, have taken the form of fluids enclosed in suitable containers. The oil or air dash-pot is a common form of this type of damping unit. Another scheme uses vanes moving in the damping liquid. In both of these types the damping depends upon the stirring of a fluid by a movable element, but the same result can be obtained by forcing the fluid through suitably shaped passages in which case the damping is produced by the friction of the fluid in contact with the stationary walls of the passages.

In many instances the latter type of damping element is the most satisfactory of those yet developed, and has been used by the Western Electric Company in different devices for many years. One form of it is used in the electrostatic transmitter described by E. C. Wente in 1917. Here a suitably shaped cavity back of the diaphragm is filled with air and is so arranged that as the diaphragm vibrates to and fro, air is forced alternately in and out through holes in one wall of the

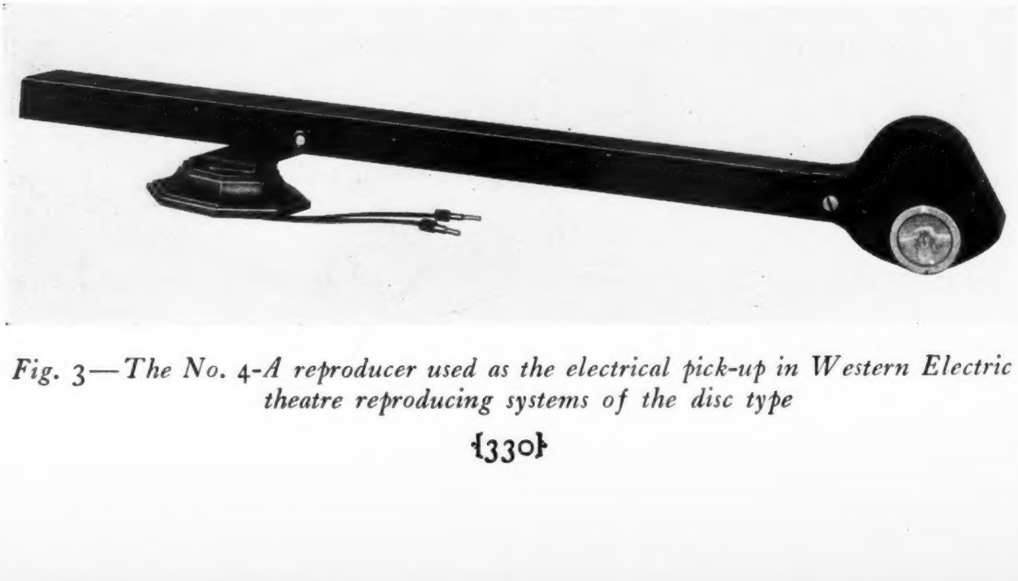


Fig. 3—The No. 4-A reproducer used as the electrical pick-up in Western Electric theatre reproducing systems of the disc type

cavity. The construction can be made small in size and gives good results in a transmitter where the amplitudes of the displacements are microscopic but it is not adaptable to the electrical reproducer where displacements of several thousandths of an inch are often encountered.

Although Wente's work involved the use of air, other fluids might be used with similar results for larger amplitudes. Oils, for example, have been frequently used in the chamber instead of air. One such construction is employed in the design of the No. 4-A reproducer used for the electro-mechanical pick-up for Western Electric sound-picture systems. Here the vibrating system has a diaphragm clamped at its periphery but free to rock about a diameter as a pivot. A plate is provided behind and parallel with the normal position of the diaphragm and the whole structure is filled with a rather viscous oil. As the diaphragm rocks back and forth under the influence of a driving needle, the oil between the plate and the diaphragm is swished about, tending to damp the motion. This construction is readily adaptable to the reproducer, mechanically, and is simple and inexpensive. The damping system is indicated in Figure 2, and the complete reproducer is shown in Figure 3. The effectiveness of the damping arrangement is evident from a comparison of Figures 1 and 4. In the former case no damping was used and the resonant peak at a frequency of about 2300 cycles is quite evident. In the latter case the damping was applied and the peak is almost completely eliminated.

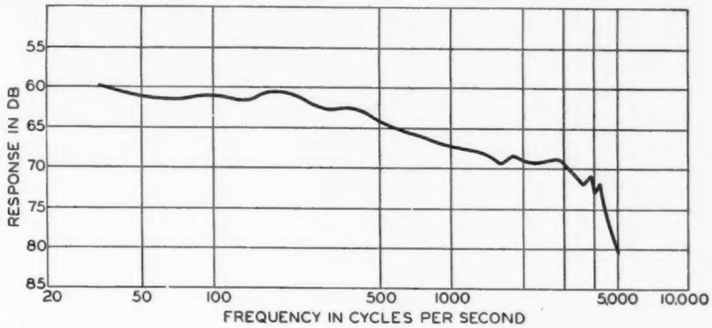


Fig. 4—With damping the peaks in the response curve of the No. 4-A reproducer, Figure 1, have been almost completely eliminated

The design of the No. 4-A reproducer, which was a pioneer in the field of oil damped devices of its kind, involved a number of new problems—concerning particularly the characteristics of the oil. A definite viscosity is desired which should not vary to any great degree with either temperature or age. A substance like molasses, with a viscosity that varies greatly between summer and winter, would be very undesirable. Also the liquid must not jelly with age, as linseed oil does, and so require replacement after a moderate length of life, nor should it corrode the metal parts with which it comes in contact. Since 1927 about 40,000 of the No. 4-A reproducers have been supplied by the Western Electric Company as standard equipment in their sound-picture and other reproducing systems. During this time practically no replacements due to aging or other operational defects have been made.

Theatre System for the Hard of Hearing

By B. LEUVELINK
Special Products Development

WITH the introduction of sound pictures the necessity for the caption, or subtitle, vanished. We needed no longer to be informed by a notice on the screen that "John, the youngest son of Abner Fairchild, was the black sheep of the family" as this could be learned from the dialogue spoken in association with the picture. But the elimination of the caption did present a problem which perhaps hardly entered the thoughts of most of us. For how were people with impaired hearing to understand the continuity of the motion-picture play if their reliance in the past, the caption, was no longer used?

Fig. 1—The armored conduit is clamped to the frame of the theatre seat and terminates in a jack capable of supplying two telephone sets

On checking the U. S. Government statistics, it was found that there are approximately 15,000,000 people in the United States afflicted with varying degrees of deafness; of these 8,000,000 are in a class which can be made to hear with the aid of acoustical amplification. In view of this, the need was evident for a system whereby these people would be able to enjoy sound pictures.

At the time sound pictures became a factor in the amusement world, we had already developed a deaf system for use in churches and lecture auditoriums to aid persons with impaired hearing. This system consists of a transmitter, which is placed on the pulpit or speaker's platform for picking up sound vibrations, batteries for the transmitter and an amplifier for reinforcing or amplifying the energy received from the transmitter. From the amplifier the energy is distributed to a number of jacks which are located on the seats. The persons having defective hearing are provided with telephone sets which are to be plugged into the jacks. The telephone-set cord has a potentiometer which permits the listener to vary the intensity

Fig. 2—The No. 51-A amplifier used in the theatre deaf system. It supplies thirty individual sets

of the sound emitted from the receiver.

With the telephone sets and amplifier of the church deaf equipment as a basis, a system was devised to aid persons of impaired hearing in sound-picture theatres. It was first publicly demonstrated at the Cleveland meeting of the American Federation of Organizations for the Hard of Hearing in Cleveland in the summer of 1929 and was received with interest and approval by the delegates. Later, in August, 1929, a trial installation to accommodate twenty persons was made up and installed in the Brooklyn Paramount Theatre. The jacks were located on seats in the back rows of the center of the mezzanine, which is one of the choice locations of the theatre. Representatives of the New York League for the Hard of Hearing were then invited to attend a performance to test the efficiency of the installation.

With not a little anticipation and some questioning, the hard of hearing adjusted the receivers to their heads, took the volume controls in their hands and listened. A sound picture featuring George Bancroft—one of his earliest—was flashed on the screen. It was not necessary to ask them if they understood the words and music or if they followed the action. The expression of their faces told the story. A vast realm of new entertainment had been thrown open to them—persons to whom many amusements were denied and to whom the silent movie had been a special attraction. Talkies had won one of the most ardent classes of supporters of the silent pictures. As a result of this trial installation, the theatre deaf system was developed consisting of a No. 51-A Amplifier, a number of No. 6055-C Telephone Sets, a power panel

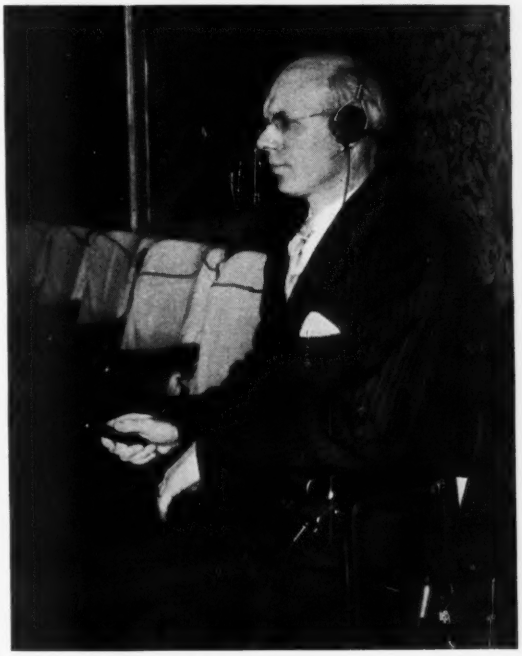
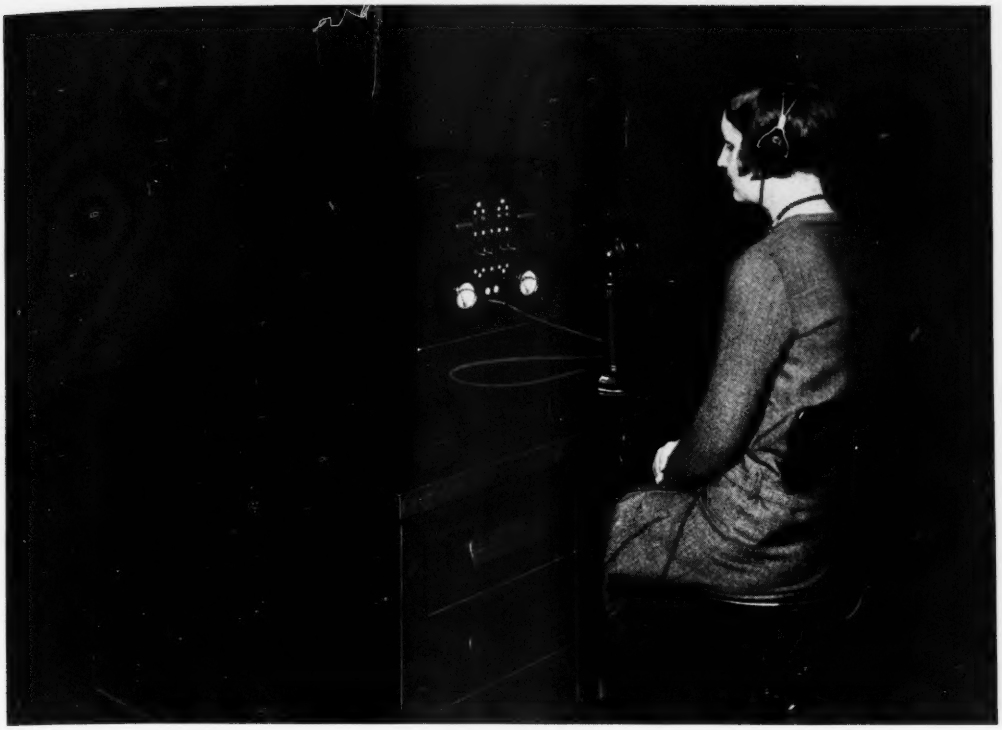


Fig. 3—The cord is plugged into the jack under the arm of the seat and the intensity of sound is controlled by the potentiometer in the hand of the listener

and a number of jacks for plugging in the telephone sets.

Instead of supplying the energy to amplifiers from a transmitter, as in the church systems, this system is operated by taking a small amount of energy from the theatre-amplifying unit. The main problem confronting the engineers was to arrange a circuit which would in no way impair the quality of the main theatre system. After a study of the various possibilities, a circuit satisfactory in this respect and fulfilling all essentials was developed. The apparatus comprising this circuit is mounted on a steel panel which is arranged for relay rack mounting with the theatre amplifiers. A smaller panel was developed for use in theatres where the rack-mounted amplifiers are not used. This panel is arranged to be mounted in what is known as the "A" box, a cabinet in which the wiring of the theatre sound system terminates. The circuit is provided with taps, whereby the input level to the deaf system may be set depending on the volume of the theatre amplifying system. The output of the panel is connected to the No. 51-A Amplifier, which in turn is connected to the jacks under the theatre seat arms.

A jack was designed for plugging in two telephone sets. This jack is mounted under the front end of the theatre-seat arm and is provided with clamps for fastening it to the iron stand of the theatre seat. It has a length of armored cable which is run along the arm and the back of the theatre seats. The free end of the cable has a metal bushing which is screwed onto the cover of the outlet boxes of the deaf-conduit system. A system using a single No. 51-A Amplifier is capable of supplying thirty telephone sets. At the present time nearly 100 theatres in various parts of the country have equipped sections of their seats to provide sound-picture reception for the hard of hearing.



Correct Time by Telephone

By H. A. LEWIS
Equipment Development

NEW equipment for giving the time of day has recently been developed by the Laboratories. A subscriber wishing the correct time lifts his receiver from the hook and requests the number assigned to the Time Bureau, or dials it if he is in a dial area. Shortly after he will hear an operator make some such announcement as: "When you hear the tone signal it will be exactly 10:45¼ A.M." A moment later, when it is just that time, a short thousand-cycle tone will be heard.

The equipment provided by the various associated operating companies to render time service will consist of a desk with a small turret as shown in the headpiece to this article. Located in some quiet room it will require but a single operator. On the turret before her are two small indicators, with faces not unlike the mileage indicator of a car, which indicate the time in quarter-minute steps. At a predetermined interval before each quarter-minute change, a green signal on the turret lights, and the operator immediately begins her announcement. The lighting of the green signal and, as a result, the operator's announcement are made only when one or more subscribers are connected to the Time Bureau, which is also indicated by the lighting of a lamp, in this case behind a white lamp cap. White light, green light, announcement, and tone signal follow each other with carefully regu-

lated precision, although during a large part of the day the white signal remains lighted constantly since there are almost always one or more subscribers connected to the Bureau.

Only a single operator at the Time Bureau is required for an entire exchange area, and only one talking path from the Bureau to each local central-office building for all calls originating from the central-office units the building contains. In the multiple of the subscribers' board of all offices in the area are time-announcement trunks as required by the traffic. Upon receiving a request for time, the operator immediately inserts the calling plug of her cord into the first idle trunk of the time group, and it is this action that causes the white signal to light at the Time Bureau. All announcement trunks are arranged to give answering supervision, which permits charging for the time service as for a local call.

A simplified schematic for the time system is shown in Figure 1. In brief, the system provides amplification for the announcement by desk equipment at the Time Bureau, with a multiplication of the outgoing circuits by outgoing distributing equipment. A further amplification and trunk multiplication is provided at the terminating offices. Here incoming announcement equipment corresponds to the desk equipment at the Time Bureau, and announcement trunk equipment, to the outgoing distributing equipment. Where greater numbers of trunks are required or where the length of a trunk makes additional amplification necessary, provision is made for intermediate equipment where amplification and trunk multiplication are also arranged for by means of similar equipment. Terminating office equipment may also be provided at the intermediate offices to serve local time calls.

To insure continuity of service duplicate equipments are provided in the turret and this duplication is also provided by two desk equipments and repeaters on the relay racks at the time office, and by somewhat similar incoming equipments at the terminating and intermediate offices. In addition a large proportion of the relay contacts

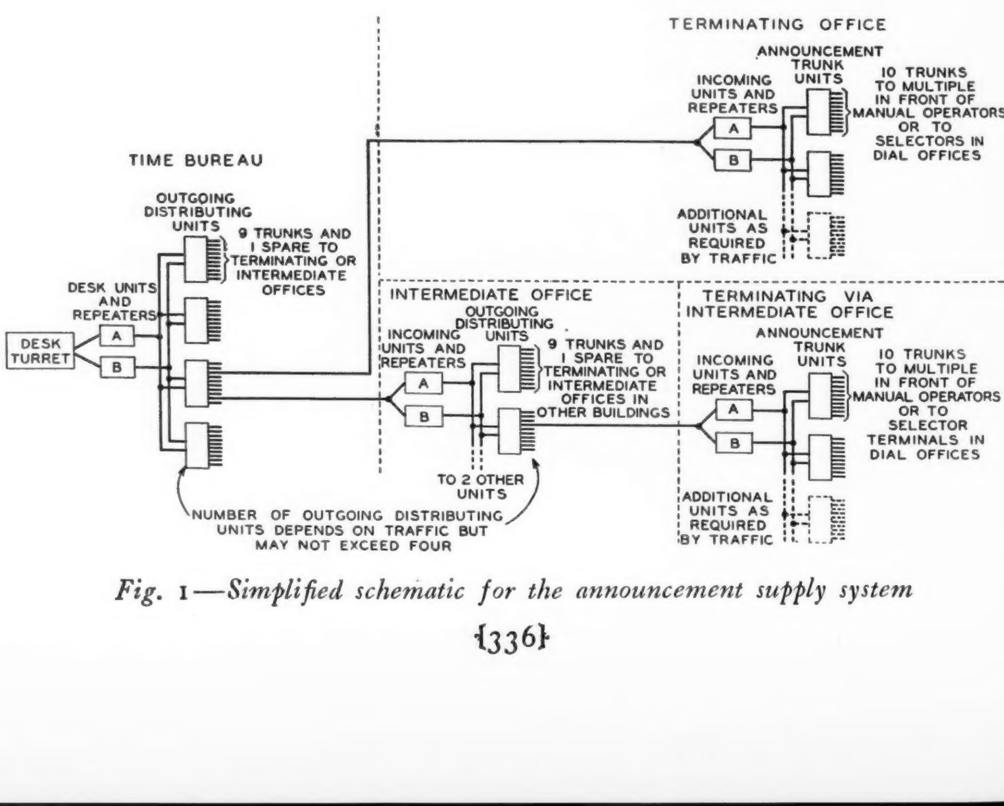


Fig. 1—Simplified schematic for the announcement supply system

have been doubled; two separate sets of contacts have been provided in parallel to perform the function of one set and thus make contact more certain.

With the exception of the operating unit for Announcement Desk No. 1, comprising a flat-top desk with a turret and high quality transmitter and two wall-mounted master clocks, all equipment for this system is in the form of units mounted on relay racks. Each of these units is made up of a framework upon which is mounted all the apparatus associated with a specified number of circuits. The apparatus is wired by the Western Electric Company before the unit leaves the shop and the wiring is terminated on terminal strips mounted on the framework. This equipment design facilitates the work of installation and reduces the cost of the equipment by allowing the production of completed items by the shop instead of only component parts.

The outgoing distributing units, used at the Time Bureau and at intermediate offices and of which there are not more than four at one place, are each arranged for nine trunks and one spare. The announcement trunk units used at terminating offices, (or in intermediate offices for terminal use), and of which there may be any desired number at each office, are arranged for ten trunks each. The latter units are of three varieties: one for manual offices, one for step-by-step dial offices, and one for panel dial offices.

By means of the announcement trunk units any number of subscribers may be connected to the time bureau at a time and hear the same announcement. The subscribers will not be able to talk to each other, however, or to the operator, due to the design of the terminating amplifiers. This feature is provided to prevent one subscriber from interfering with the service being rendered to others.

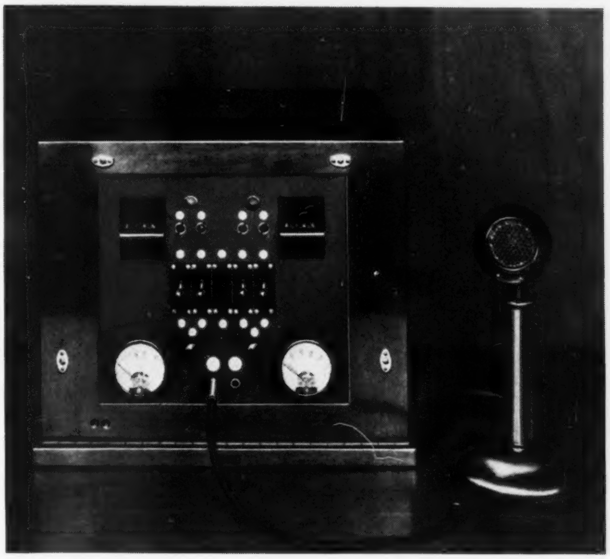
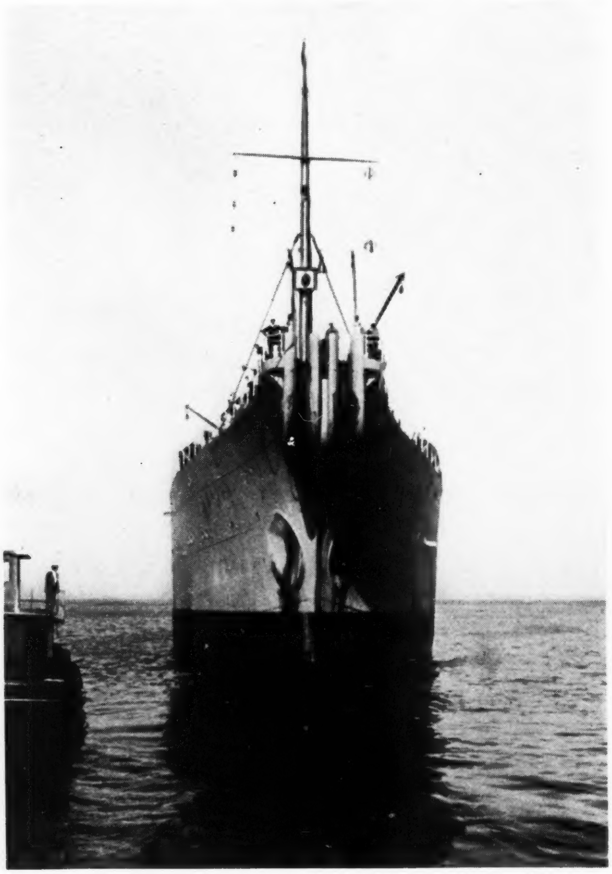


Fig. 2—Front view of time turret known as Announcement Desk No. 1

The equipment on the turret and its method of operation may be understood better by reference to Figure 2. The arrangement is symmetrical, with equipment for one circuit mounted on each side of the front panel. Small electric clocks which indicate the time in quarter-minute intervals are mounted in the upper corners of the front panel. They are controlled by master clocks, two of which are mounted on the wall of the room in front of the operator, which are in turn controlled by a district master serving the area in which the Time Bureau is located. Between the clocks on the turret are two groups of lamps, each containing one which

lights whenever a call-waiting condition exists, one red lamp to indicate when the circuit is out of service and should not be used, and a large green lamp by which the operator times her announcement. The tone signal is sent out immediately after the green lamp is extinguished.

Below the lamps are four lever-type keys: two for bringing the clocks into step with the master clocks on the wall, and two for raising or lowering the transmission level of the operator's voice, which is gauged by the volume indicators in the lower corners of the panel. Between the volume indicators are two push-type keys, one for signalling the maintenance force and one for summoning the supervisor. Two jacks are available for the high-quality transmitter used for the announcements. Transferring the transmitter from one to the other automatically switches the control of the circuits from one desk unit to the other. The operator is provided with a headset so that she may hear the time signals, and jacks for the headset are mounted in the knee well of the desk.

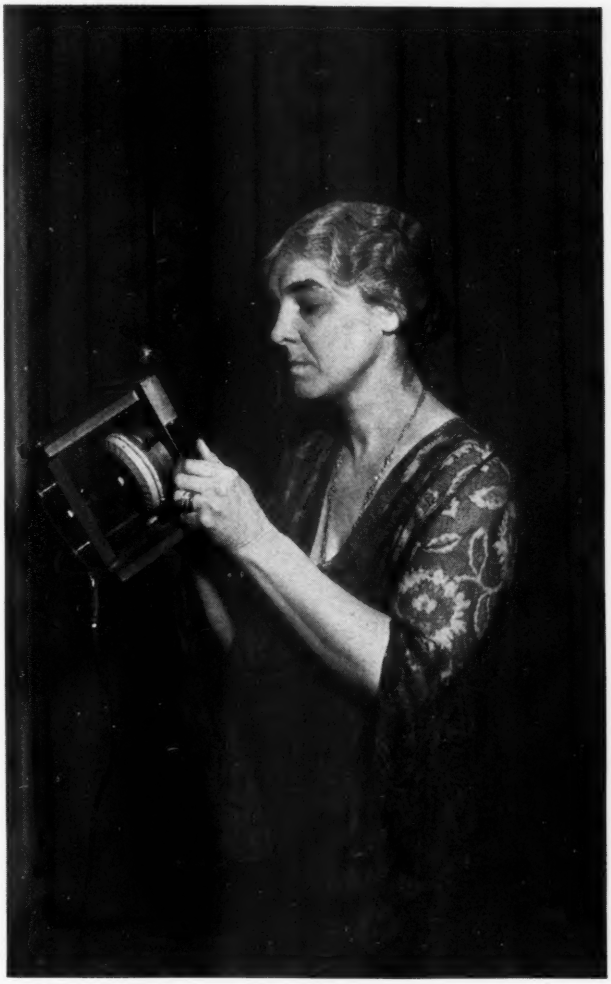


The cable ship "Neptun" from which the new Key-West-Havana cable was laid across Florida Straits

NEWS AND PICTURES

of the

MONTH



Mrs. Gilbert Grosvenor, daughter of Alexander Graham Bell, speaking through replica of her father's notable invention during S. P. Grace's address at Washington

General News Items

Sign Language Conversation Held Over Two-way System

The two-way television system enabled Dr. Thomas F. Fox to carry on a conversation over wire-transmission facilities for the first time. Dr. Fox, who has been without hearing since his early boyhood, spoke with his son Edwin R. B. Fox by means of the sign language of finger movements. After a few preliminary movements necessary to adjust themselves to this unique method of holding a conversation, neither Dr. Fox nor his son, whose hearing is normal, experienced any difficulty in interpreting the various signs made by the fingers and transmitted over the television system. Arrangements for the talk were made by the New York Telephone Company.

This was the second instance of conversation carried on by visual instead of aural means over telephone wires. Several months ago Miss Evelyn Parry, national lip reading champion, spoke with her teacher through lip movements transmitted by the television apparatus.

German Cable Engineers Guests at Luncheon

On January 21 Messrs. Engler and Havernith of Norddeutsche Seekabelwerke, Nordenham, Germany, were luncheon guests of Mr. Charlesworth, his staff, and O. E. Buckley, R. R. Williams, J. J. Gilbert, G. A. Anderegg, W. S. Gorton, B. Trebes, D. A. Quarles, B. W. Kendall, and H. H. Lowry, members of the Technical Staff associated with submarine cable work.

Messrs. Engler and Havernith came from Germany on the cableship *Neptun* and were on the boat during the laying of the Key West-Havana telephone cable from December 14 to January 10. Following the completion of the work, they left Key West for New York. The cable was manufactured at the Norddeutsche Seekabelwerke in Nordenham.

First Dial 'A' Boards to be Installed in New Jersey

The first commercial installations of the dial systems 'A' board of the key-pulsing type, recently developed in these Laboratories, will take place in Newark and the Oranges. They are to be included in the dial units ordered by the New Jersey Bell Telephone Company as part of the replacement program of central offices in metropolitan New Jersey. The Mulberry semi-mechanical unit in Newark, the first installation of this type of equipment, is included in the replacement project which is scheduled for completion in 1932.

Historical Curios Used at Washington Meeting

At the address given by S. P. Grace January 23 before the National Geographic Society at Washington, Mrs. Gilbert Grosvenor, daughter of Alexander Graham Bell, spoke into a replica of the original telephone instrument used by her father in 1876.

Her words, expressing gratitude to Mr. Grace for the opportunity to address the members of the National Geographic Society through the historic instrument, were transmitted through an amplifier and clearly heard by an audience of 6,400 at the Washington Auditorium.

The invention of the telephone was further celebrated by inserting in the circuit of the call announcer a section of the wire used by Bell in the first demonstration of the telephone. This was the first occasion when speech from a mechanical source was transmitted over that wire.

Mr. Grace described and demonstrated delayed and scrambled speech, the singing flame, and the magnetic behavior of permalloy. Among recent advances of telephone research and development work he mentioned the Key West-Havana telephone cable and explained the added efficiency given it by paragutta insulation, a development of chemical research in the Laboratories.

The meeting was presided over by Gilbert Grosvenor, president of the National Geographic Society and editor of its magazine. R. M. Pease assisted Mr. Grace and Curator W. C. F. Farnell aided in the exhibit of the historic apparatus.

The Chamber of Commerce of Charleston, West Virginia, and an audience of 2000 persons heard Mr. Grace on January 29. Requests for admission by almost as many persons had to be turned down owing to the limitations of the auditorium. Local arrangements for the meeting were cared for by General Manager V. B. Fitzpatrick and his aides of the Chesapeake and Potomac Telephone Company of West Virginia.

Mr. Grace addressed an audience of 5000 persons in Roanoke, Virginia, on February 6, where he spoke at the invitation of the Chamber of Commerce.

Dr. Pupin Visits Laboratories

Michael I. Pupin, professor emeritus of Columbia University and noted authority on electromagnetics, was a visitor to the Laboratories on February 13 at the invitation of William Fondiller, Assistant Director of Apparatus Development. He was guest of honor at a luncheon at which were present Mr. Charlesworth, Mr. Fondiller, H. D. Arnold, R. L. Jones, J. G. Roberts, John Mills, O. E. Buckley and B. W. Kendall. Following the luncheon Messrs. Fondiller, Buckley, Kendall, H. H. Lowry, G. W. Elmen, F. S. Goucher and P. P. Cioffi reviewed with Professor Pupin some of the recent developments of the Laboratories.

ADMINISTRATION

Mr. Charlesworth spoke before the Northern Electric Engineering Society at Montreal on February 3. On February 4 he gave an after-luncheon talk at the Electrical Club of Montreal on *Research in Communication*. Later he addressed the supervisory officials of The Bell Telephone Company of Canada. While in Montreal, he was also a guest of the Council of The Engineering Institute of Canada at its annual dinner.

H. D. Arnold's address *Atoms and Electrons* delivered before the Los Angeles section of the A. I. E. E. was received with much interest in the West. The meeting was one of the largest of the year and the talk was reported at length by the Los Angeles newspapers. Dr. Arnold returned to New York on February 6.

Departmental News

Systems Development Manual Equipment

C. A. SMITH has spent several weeks in Richmond, Durham, Greensboro, Charlotte, and Greenville, in connection with the trial installation of the new repeater for long four-wire circuits. The Washington-Atlanta toll telephone cable passes through each of these places.

EQUIPMENT FEATURES of the No. 3 toll switchboard and the No. 8 test and control board at Hempstead were inspected by R. E. Ottman and R. A. Jascoviak.

A. D. KNOWLTON and A. C. GILMORE visited Millington, New Jersey, with engineers of the American Telephone and Telegraph Company to consider the location of dialing equipment in magnetic offices. In company with C. E. Boman and Western Electric engineers, Mr. Knowlton visited Scarsdale and Dobbs Ferry, New York, in connection with cabling and installing problems on the large manual switchboards.

Special Equipment

J. A. WORD assisted in a trial installation at Charlotte, North Carolina, of an echo suppressor for the Charlotte terminal of the New York-Charlotte toll cable.

C. A. HEBERT visited Hartford to discuss with the Southern New England Telephone Company a trial installation of service-observing equipment for the step-by-step system in that city.

Toll Circuit Development

A. F. GRENELL was present at the opening of the new ship-to-shore radio transmitting station at Ocean Gate.

THE OPERATION OF echo-suppressor circuits was inspected by P. W. Wadsworth at Albany.

A. E. BACHELET was in Morristown, New Jersey, inspecting a trial installation of program-supply circuits over B-22 cable facilities.

T. V. CURLEY visited Aurora and Evanston, Illinois, to observe an installation of recording-completing trunks arranged for number checking.

A CONFERENCE ON the requirements for the new high insulation Wheatstone Bridge circuit required F. B. Anderson's presence at the Leeds and Northrup Company in Philadelphia.

B. MCWHAN supervised the operation of the voice-frequency dialing equipment in conjunction with S. P. Grace's demonstrations of the call announcer at Washington, Charleston and Roanoke.

Carrier and Repeater Development

J. P. KINZER was at the Morristown, New Jersey, repeater station to investigate the operation of 44-A-1 telephone repeaters.

ALSO AT MORRISTOWN, H. K. Krist has been making impedance and attenuation measurements on the three-mile length of experimental cable as part of the trial of the new carrier-on-cable system.

Power Development

A visit to Aurora, Illinois, was made by J. R. Stone to investigate the operation of the pneumatic-tube system recently installed in that city.

H. M. Spicer discussed power control apparatus with the General Electric engineers at Schenectady.

Systems Drafting

H. C. Dieffenbach has completed twenty years in the Bell System.

Local Central Office

At Asbury Park and Spring Lake, New Jersey, R. C. Kraft and R. F. Massonneau, with R. L. Pentland of the American Telephone and Telegraph Company, observed the reception of signals from the call announcers recently installed in the Panel Tandem Office, East 13th Street, New York.

W. M. Beaumont has completed twenty years in the Bell System.

Local Systems

W. J. Lacerte spent a week in Pittsburgh to observe the operation of the new interconnecting system for the various step-by-step private branch exchanges of the Pennsylvania Railroad in that area.

G. A. Hurst was at Chicago to inspect the new Panel Tandem office which automatically completes calls to both step-by-step and manual offices by means of equipment which transforms pulses from panel offices into step-by-step signals, and by the call announcer for manual offices.

L. T. Anderson and J. C. Crouch were in charge of the call-announcing equipment used in connection with Mr. Grace's demonstrations in Washington, Charleston, and Roanoke.

Twenty-five years with the Bell System were completed by L. J. Bowne on February 19. His association with the telephone industry began with the New York Telephone Company as an inspector of subscriber's apparatus. He was engaged in this work and the

L. J. Bowne

inspection and repair of PBX's until 1911.

After a brief absence from the employment of the telephone company he was assigned to trial installation work of the start-stop printing telegraph. He continued with the New York Telephone Company as an inspector and installer of apparatus until 1919 when he came to the Engineering Department of the Western Electric Company.

Since then Mr. Bowne has been engaged mainly on circuit engineering. For a period of several months he worked on toll signalling design and in 1925 became a member of his present group engaged on PBX circuit design.

Dial Equipment

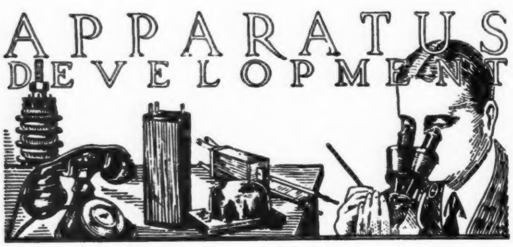
M. P. Sherwood discussed various problems in connection with the de-

sign of test frames for panel offices with the Western Electric staff at Hawthorne.

INSPECTION ENGINEERING

DURING THE latter part of January, H. L. Kitts completed an investigation of sound picture apparatus at the Hawthorne plant of the Western Electric Company and at the Chicago Warehouse of Electrical Research Products, Inc.

L. E. GAIGE, Field Engineer at Detroit, spent several days in Holland, Michigan, conducting trials on modifications of step-by-step code ringing circuits suggested by the Laboratories.



SPECIAL PRODUCTS

H. C. CURL visited the Bureau of Engineering of the U. S. Navy Department in Washington, to discuss problems pertaining to naval communication systems.

C. F. EYRING and F. A. GOSS in company with E. H. Bedell of the Research Department spent the week of January 12 in Washington conducting sound and reverberation measurements in collaboration with members of the Bureau of Standards.

R. M. PEASE spoke before a Colloquium at Brown University on *Facts and Figures of Sound Pictures.* He has assisted S. P. Grace in lecture-demonstrations in Charleston, West Virginia, and Roanoke and Norfolk, Virginia.

F. W. CUNNINGHAM with L. E. Whittemore of the American Telephone and Telegraph Company visited Washington to confer with members of the Engineering Division of the Federal Radio Commission.

F. H. MCINTOSH visited Cleveland to supervise the installation of a 1-kw radio-telephone broadcasting equipment for WGAR, Incorporated, and to inspect station WHK owned by the Radio Air Service Corporation. Later he inspected stations WCAE and WCAM owned respectively by Gimbel Brothers, Pittsburgh, and the City of Camden, New Jersey.

B. R. COLE visited Syracuse to supervise the installation of a 5-kw radio-telephone broadcasting equipment for the Onondaga Radio Broadcasting Corporation.

THE INSTALLATION of a 1-kw radio-telephone broadcasting and associated speech-input equipment for the Saenger Amusement Company of New Orleans was supervised by A. B. Bailey. He also inspected stations WODX, WSFA and WRVA located in Mobile and Montgomery, Alabama, and Richmond, Virginia.

CAPTAIN P. D. LUCAS piloted the Laboratories' Fairchild airplane on a flight to Bellefonte, Pennsylvania, during which J. W. Greig and D. B. McKey made a test of a visual course indicator for airplanes.

H. E. J. SMITH supervised the installation of a 400-watt radio telephone equipment for the Metropolitan Police Department, Washington.

O. W. TOWNER visited numerous stations in the Mountain and Pacific Coast States on an inspection tour of Western Electric equipped broadcasting stations in these regions. He returned to the laboratories on Feb. 9 after being away since early in August.

Transmission Apparatus

W. J. Shackelton attended meetings of the A. I. E. E. Committee on Instruments and Measurements, and the Sectional Committee on Electrical Definitions.

To observe in various sections of the country trial installations of lacquer-treated wire for central offices, O. C. Eliason and H. H. Glenn visited Washington, Philadelphia, and several places in Northern New Jersey. With E. B. Wood, Mr. Eliason also went to New Haven.

S. G. Hale was at Hawthorne in connection with the production and testing of loading units for use on the Newark-Philadelphia cable.

A. R. Swoboda completed twenty years as a member of the Bell System on February 17.

Materials

H. B. Smith was at Hawthorne from January 4 to 11 studying manufacturing troubles on multiple banks. He described the dial system in a recent talk given at Masonic Temple, New York City.

W. A. Evans and T. S. Huxham visited the Bakelite Corporation at Bloomfield, New Jersey, to discuss various molding problems.

I. V. Williams made a trip to the J. Weiss and Sons plant at Newark, in connection with the manufacture of a special form of scissors for telephone-typewriter tape.

Manual Apparatus

Messrs. J. O. Carr and A. H. Reiber of the Teletype Corporation, accompanied by Mr. E. Kleinschmidt, formerly Vice-President of that Corporation, visited the Laboratories for conferences on the printing telegraph.

A visit to the Holmdel and Deal Beach short-wave radio stations was made by S. T. Curran in company with R. H. Wilson, E. G. Conover and W. C. Pitman of the Research Department to inspect the fire protection facilities of these stations.

W. J. Means with F. H. Best (A T. & T. Co.) visited the Weston Electrical Instrument Company at Newark to inspect a model of a new recording meter which is being developed in collaboration with the Laboratories.

Mr. A. C. Link of the Hawthorne Manufacturing Planning Organization and Messrs. W. C. M. Cropper and R. L. Elliott of the Northern Electric Company visited the Laboratories in connection with apparatus manufacturing problems.

Dial Apparatus

Twenty-five years in the Western Electric Company and Bell Telephone Laboratories were completed by George W. Folkner on February 7. He became a member of the Apparatus Drafting Branch of the Western Electric Company in this building in 1906 following six years of employ-

G. W. Folkner

ment in the Edison Machine Shops at Orange, New Jersey.

When the manufacture of relays, drops, signals, and their mounting plates was transferred to Hawthorne in 1909 Mr. Folkner left New York and remained at Hawthorne until 1915. In 1912 when the manufacture of the first large trial installations of panel dial apparatus was authorized he was responsible for the preparation of the manufacturing information. He remained on this work until the apparatus for the early trials was completed.

Returning to New York as a member of the Engineering Department of Western Electric, he was placed in charge of drafting and detail-design studies of panel apparatus. In 1918 he assumed his present work in charge of the general engineering of panel dial apparatus. He has made many contributions to the efficiency of the present dial switching units of the panel type.

Mr. Folkner relates that at the time of his employment he was told that his practical experience in a field somewhat similar to the Bell System's would materially aid him in the work he was about to undertake. This information inspired him to keep in touch with the practical side of telephone work and as a result he has specialized in proportioning and standardizing details of design for quantity production. As an interlude in eliminating manufacturing difficulties and holding down costs, Mr. Folkner applies himself to hunting and fishing.

NEW DEVELOPMENTS on vitreous enamelled resistances required R. A. Ogg's attention on a recent visit to Hawthorne.

AT HAWTHORNE also D. H. Gleason attended conferences with the Manufacturng Department on the new small ringer.

D. C. LLOYD was at Kingston, New York, for tests of contacts in pilot wire regulators.

J. R. IRWIN visited the Trinity Exchange in Philadelphia to investigate sequence-switch contact protection.

DRAFTING AND SPECIFICATIONS

W. S. BOERCKEL celebrated the twenty-fifth anniversary of his association with the Western Electric Company and Laboratories on February 5. He has been engaged chiefly on drafting work and at the present time is in charge of coordination of design details for transmitters, receivers, loud speakers, and other apparatus.

W. S. Boerckel

Mr. Boerckel became a member of the Shop Drafting group and worked in this department until 1913 when the manufacturing activities at 463 West Street were transferred to Hawthorne. He remained in New York, however, and was soon delegated to drafting work on the development of semi-mechanical equipment. When need arose, a short time later, for a

shop draftsman with experience in receiving and transmitter design he was assigned to the Transmitter and Receiver Development group. There he had an important part in the installation of the communicating system of the U. S. S. Arizona, one of the earliest installations of loudspeakers. Later he worked on the development of systems using loudspeakers for train dispatching, public address, and battleship communication. The installation of public address systems at the Victory way celebration in 1919 and at the inauguration of President Harding were projects on which he worked as a member of this group.

PATENT

John A. Hall on January 30 sailed for London to take charge of the European Patent Department of Electrical Research Products, Inc. He will replace J. C. R. Palmer, who is returning to this country. A farewell dinner was given Mr. Hall at the Elks Club in Jersey City on January 24, followed by a theater party.

A. J. Zerbarini, R. Marino, and C. H. Brown were recently admitted to the New York Bar

J. G. Roberts and H. F. Beck attended at Atlantic City a conference on patents relating to sound picture apparatus.

During the month of January routine patent matters required the presence in Washington of F. G. Braham, F. H. Crews, O. D. M. Guthe, I. MacDonald and J. F. McEneany.

A. G. Kingman was in the Middle West in connection with problems relating to pending patent litigation.

The following members of the Patent Department have in recent months been admitted to the New York Bar; C. H. Brown, R. Marino and A. J. Zerbarini.

Transmission Instruments

H. B. Ely and N. Blount were at Hawthorne to discuss manufacturing plans for loud speakers and other transmission instruments.

C. B. Northrop was at the Columbia Phonograph Company's plant at Bridgeport in connection with special recording work.

Chemical Laboratories

Copper and brass problems were discussed by E. E. Schumacher on a visit to the Chase Brass Company's plant at Waterbury, Connecticut.

L. E. KROHN was in Chicago from January 5 to 11 in connection with work on panel-type banks.

R. L. PEEK and D. A. MCLEAN attended the meeting of the Rheology Society at Easton, Pennsylvania. A paper *Some Physical Concepts in Theories of Plastic Flow,* written under their joint authorship, was read by Mr. Peek.

AN ARTICLE by A. R. Kemp describing Paragutta, the new insulating material for submarine cables, is published in the January number of the *Journal of the Franklin Institute.*

THE MEASUREMENT of abrasion resistance of paints, varnishes and lacquers is discussed by A. E. Schuh and E. W. Kern in a paper in the January 15 Analytical Edition of *Industrial and Engineering Chemistry.*

ACOUSTICAL RESEARCH

L. J. SIVIAN has returned from California where he attended the meeting of the Acoustical Society. He presented the paper *Measurement of Reverberation Time and its Application to the Acoustics of Talking Pictures* before the meeting.

J. B. KELLY read a paper *Some Investigations of Speech and Hearing* before the Lynn section, A. I. E. E.

SUBMARINE CABLE

J. J. GILBERT has returned from Havana. He was on the cable ship *Neptun* and observed the laying of the Key West-Havana cable. E. W. Waters, who was also at Key West and Havana in connection with the laying of the cable, has returned to New York.

B. TREBES sailed for Germany January 23, on work in connection with the development of undersea telephone cable. Shortly before leaving for Germany he was at Key West and Havana to observe the laying of the Key-West Havana cable.

TRANSMISSION RESEARCH

J. H. BOLLMAN was at Washington to adjust the standard of frequency at the Bureau of Standards. The standard is similar to the one maintained in these Laboratories.

FRIENDS OF J. S. LOW of the Transmission Research Department were shocked to learn of his death which occurred January 23 after a ten-days' illness of pneumonia. He was twenty-four years old and had been a member of the Laboratories since May, 1930, following his graduation from Stanford University. His home was in Berkeley, California.

J. S. Low

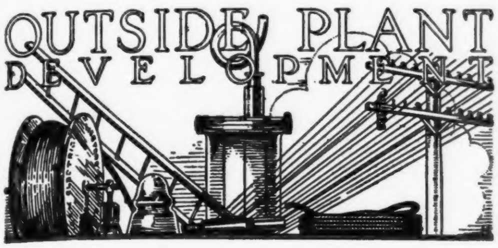
LABORATORY ENGINEERING

R. O. MERCNER visited the Vibration Specialty Company's plant in Philadelphia in connection with apparatus required for the transmission of pictures over telephone lines.

RADIO RESEARCH

F. A. POLKINGHORN gave a talk on Transatlantic Telephony before a

group of the New York alumni members of the Theta Upsilon Omega Fraternity at the Fraternity Clubs' building, New York. on January 20.



The annual meeting of the American Wood Preservers Association at Philadelphia was attended by S. C. Miller, R. H. Colley, and C. H. Amadon. Mr. Miller also visited Point Breeze in regard to the manufacture of cable terminals.

F. F. Farnsworth has been in Chicago at a joint conference of the American Electroplaters and the American Society for Testing Materials. Mr. Farnsworth also visited Detroit in connection with motor vehicle finishes.

During the week beginning January 19, J. G. Brearley was at Appleton, Wisconsin, with Mr. Richey of the American Telephone and Telegraph Company to observe the installation of commercial cable having a new type of sheath. They also visited Hawthorne to discuss development problems on this cable.

F. B. Livingston was at Detroit in connection with the installation of terminating cable with treated textile insulation.

STAFF

Miss H. M. Craig of the library staff has been elected President of the Graduates' Association of the Pratt Institute School of Library Science.

Miss Anna A. Kiernan, supervisor of typists in the Transcription Department, was twenty years a member of the Bell System in February.

James Barton, foreman in the Building Service, completed twenty years in the Bell System in February.

PERSONNEL

G. B. Thomas and A. F. Weber attended the Personnel and the Public Relations Conferences of the American Management Association which were held at the Hotel Niagara, Niagra Falls, New York.

PUBLICATION

G. F. Fowler has been appointed a member of the Nominating Committee of the Science Forum of the New York Electrical Society. The committee will designate candidates for the annual election of the society.

COLLOQUIUM

The members of the Colloquium were guests of the Chemical Department of the Laboratories on January 30 when Professor N. V. Sidgwick spoke in the Auditorium on the subject *Atomic Cohesion*. Dr. Sidgwick is Professor of Chemistry at Oxford and at present is filling the George F. Baker non-resident lectureship at Cornell. His talk was very much enjoyed by the large assembly present.

L. A. MacColl read a paper *The Stability of Dynamic Systems* at the meeting on January 19. It included a discussion of various concepts of the stability of a given state of motion, of the theory of motion in the neighborhood of a given motion, and of criteria for the different types of stability. Important applications of the theory were treated briefly.

Contributors to this Issue

A. R. Olpin received an A.B. degree from Brigham Young University in 1923 and remained as instructor in physics and mathematics for the following season. Then after spending a year at Columbia as graduate assistant in Physics, he joined the Laboratories in 1925. With the electro-optical group of the Research Department he has since devoted his efforts to the development of photo-electric cells, and has been instrumental in increasing their sensitivity by the use of dielectrics. Since coming to the Laboratories he has continued his graduate studies at Columbia and received his Ph.D. last year.

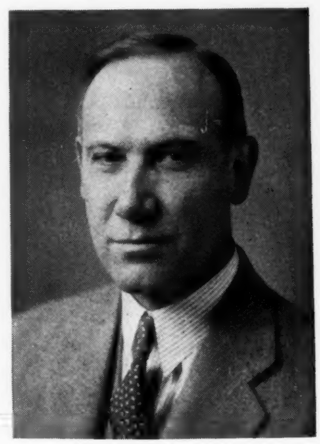
G. H. Rockwood received a B.S. degree from Dartmouth in 1924 and then after a three-year cooperative course at the Massachusetts Institute of Technology received an S.M. from the latter institution. He immediately joined the Western Electric Company and was with the Development Department at Hawthorne for the following two years. In 1929 he joined the Technical Staff of the Laboratories where, with the Research Department, he has been engaged in researches in vacuum and gas-discharge tubes.

Carl F. Eyring received his A.B. degree from Brigham Young University in 1912 and, except for leaves of absence for studies in other universities, was Professor of Physics there until he joined the Technical Staff of the Laboratories in 1929. In 1915 he received an M.A. degree from the University of Wisconsin, and in 1924 a Ph.D. from the California Institute of Technology. With the Laboratories he has been engaged in studies of the acoustics of sound-picture stages and auditoriums.

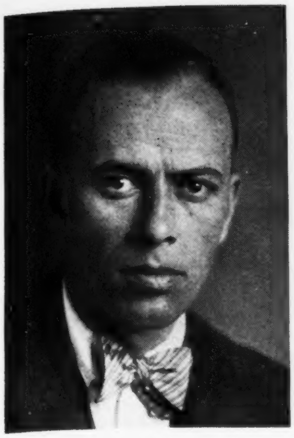
S. T. Curran left Cornell University in 1917, his senior year, to enlist in the Naval Reserve Flying Corp, and served overseas as an officer and airplane pilot engaged in convoy and submarine search operations. Return-

A. R. Olpin

G. H. Rockwood



C. F. Eyring



S. T. Curran

D. G. Blattner

B. Leuvelink

ing to civil life in 1919 he held a position with the Army Ordinance Department appraising machinery and equipment of munition manufactures until joining the Laboratories in December, 1919. He has since been engaged in the design and development of central office apparatus.

D. G. Blattner received a B.S. E.E. degree from the Kansas State Agricultural College in 1911 and remained there two years as assistant instructor in physics. The following year he joined the Western Electric Company in Chicago and after completing the Student Training Course he transferred to the Engineering Department in New York City. Here he was engaged in the development of loud speakers and public address systems. Since 1927 he has been in charge ot development work on loud speakers, and phonograph recorders and reproducers.

B. Leuvelink became a member of the Engineering Department of the Western Electric Company in 1918. He worked in the drafting department and in 1921 was assigned to the specifications group to work on writing specifications. Through night courses in Newark Technical School and Columbia University he prepared himself for electrical engineering and in 1928 transferred to the Mechanical Design division of the Special Products Department. He has specialized on the design of sound recording and reproducing equipment.

H. A. Lewis

H. A. Lewis graduated from Cornell University in 1926 with the degree of E.E., and immediately joined the Technical staff of the Laboratories. With the Equipment Development Section of the Systems Department he was first associated with the trial installations group and later engaged in the analization of Hawthorne and Kearny orders. More recently he has been concerned with the development of equipment for manual central offices.

What Hath God Wrought!

Courtesy, personified by two youthful magicians, efficiently attending an Aladdin's lamp of complete modernity, opens the door to a sound-proof booth and bids the visitor seat himself in an upholstered swivel chair whose path of freedom is ninety degrees. The visitor swings comfortably to the right. He gazes into a black cavity at the further end of which he sees the insigne of the Bell Telephone Laboraotries. There is a pause, a slight disturbance that might be called a sound.

The Bell Laboratories insigne has vanished and in its place, large photograph size, is the clearly defined face of the visitor's vis-a-vis at the other end of two miles of city streets and buildings —a speaking likeness, for it has scarcely appeared on the screen before, in tone, accent and values unmistakable, come through the words: "Why, John Henry!"

Neither raise nor lower the voice; the hidden microphone is delicately adjusted; merely think of something not utterly banal to say. There should be some inspiration in the presence of this triumphant adaptation of natural forces to the uses of man; there is not. "Did you have any trouble getting downtown?"

"Do you see me plainly?" The definition is exact; the moving eyes, the parting lips, the play of a muscle, all are transmitted without distortion. See plainly? The other day a party of deaf mutes used two-way television and the lip reader in the West Street building read the words formed by the speaker in 195 *Broadway with the same ease that would have attended their communication had they been at arm's length from each other. There is something pecularly appropriate about this: Alexander Melville Bell, inventor of "visible speech," a system of instruction used in teaching deaf mutes to speak, begat Alexander Graham Bell, and Alexander Graham was deeply interested in his father's work; and Alexander Graham Bell invented the telephone; the Bell insigne which was replaced by this speaking likeness of a person two miles away is the sign of the corporation that bears Bell's name.*

The talking picture is asking, "Have we overstayed our time?" Probably not; yet there remains nothing to say. To affront this work of genius with further commonplaces would be inpudent; the wizard of the neon tube and the witch of the loud speaker must not be tempted too far. They are entitled to consideration; indeed, they will compel consideration. Swing the chair to the left; the picture before the visitor changes from full face to right profile. Courtesy smiles at the visitor, obviously sympathetic with his bewilderment; another visitor is to be initiated into this mystery.

—An editorial in the New York Sun of February 18, 1931.